SCIENCE INFORMATION NOTES

A collection of articles on scientific and technological topics, research policies, science and society, higher learning, etc.

April, 1985

INDIAN NATIONAL SCIENCE ACADEMY
BAHADUR SHAH ZAFAR MARG, NEW DELHI - 110 002

I N D I A N N A T I O N A L S C I E N C E A C A D E M Y

SCIENCE INFORMATION NOTES

April, 1985

CONTENTS

Title	Page
MAIN ARTICLE	
Indira Gandhi : Science As Culture - A Rahman	1
Appropriate Technology Essential Medicines in the Third World - P.F.D'Arcy	7
PHYSICAL SCIENCES	
Industrial Research and Development in Australia - M. Chandra	13
Guest Evaluation Seven Years After the 1977 UN Conference on Desertification: Lessons Learned or To Be Learned - Mohamed Kassas	20
BIO-SCIENCES	
Steroid Hormone Systems Found in Yeast - Gina Kolata	27
Controlling the Body Geometic - Jullie Ann Miller	31
Probing the Molecular Effects of Dioxin - Kathy Fackelmann	33

MEDICAL SCIENCES

The Psychological Dimension in Cancer Treatment (Abstract) - Steven Greer 35

New Directions in the Understanding and Management of Pain (Abstract) - C. Richard Chapman 36

Ophthalmology in Developing Countries - John Sandford Smith 37

Drug Treatment of Parkinson's Disease - J.M.S. Pearce 43

ENERGY, ENVIRONMENT AND BIOTECHNOLOGY

A Perspective on Nuclear Power in the USA 46

Bio-Energy-Present Status and Future Perspectives -Maheshwar Dayal 55

Pesticide Policies Change Slowly - Judith S. Weis 59

Problems and Policies Associated with Acid Rain - Byrom Lees 62

Biotechnology For Development: Promise and Problems - Elmer L. Gaden 72

****
****
*****

INDIRA GANDHI: SCIENCE AS CULTURE

By A. Rahman

In ancient Greece, they did not consider any person fit for citzenship unless he was initiated in the art of politics. Indira Gandhi's vision, like that of Jawaharlal was that unless one is initiated in and is conversant with the latest developments in science and technology, one cannot call oneself a cultured person. And Indira Gandhi in all respects, represented a cultured person. She also thought that it would not be possible for people to effectively shape their destiny, improve the quality of life, and to provide the basic necessities to people and an opportunity for doing creative things in life unless they are steeped in science and in the use of latest technologies.

In her speeches on various occasions, she emphasised one or the other dimension of science or technology and its interaction with man, society or environment. There was, however, one dimension which she always emphasised: people must recognise the role of science and technology in everyday life and in development.

Like Jawaharlal, she felt that science needed a planned support and scientists should be protected from day-to-day pressures so that they can devote themselves fully to the promotion of science and its utilisation for human betterment. Her idea of betterment was not just limited to providing material needs, but included intellectual upgradation.

Speaking in 1968, at the convocation of the Indian Institute of Technology (IIT), New Delhi, she gave a clear expression to what people expected of science as also the basic prerequisites of scientific development:

"What does science mean to various people? Industrialists seek science as a means for augmenting production. Farmers look at it as a tool for growing better crops. The average citizen thinks that science will ease the hardship of his daily grind. To my father, it was a means of raising the standards of living of our people and of liberating them from prejudices and superstitions. To me, science stands for a deepening awareness of life in all its many facets. Science awakens the urge to enquire and to search for truth. It gives one the ability to observe and sharpens one's perception. It means precision and discipline in thought and action... A free flow of ideas is essential to progress. Our political life needs to be enriched by the entry of men and women brought up in the new and growing traditions of science and technology. Intellectuals and

Cont...2..

politicians must get to know and understand one another's problems.

But then science is not merely limited to that; it is something more. It is the essence of life and it is necessary that men and women who are engaged in different aspects of human activity know the wider dimensions of science in order to enrich the life of their country.

She repeatedly pointed out to administrators and to politicians that it is not only necessary to know about developments in science and technology but also to keep in close touch with these developments; she considered it particularly essential for those who are closely associated with problems and policies dealing with public life. Addressing the Indian Science Congress Association in 1968, she said:"In the world of today, all those interested in public welfare must maintain the closest contact with scientific development. No conscientious politician can be divorced from science, nor can a responsible scientist afford to remain uninterested in the policies which shape the ends for which his discoveries are used. Never have we been faced with such tremendous challenges as today when the goal of a better life is within sight and the means to attain it are within our grasp. The harnessing of new sources of energy, the invention of new techniques of agriculture and industrial production, the amazing discoveries in medicine have all created the potential for a new world".

Much later, in her address to the Institute of Economic Growth, Delhi, in 1983, she put before the economists the basic issue why and how the problem of poverty has to be addressed primordially. And in her characteristic style, she brought out the significance not only of the existence of poverty, but the frame work or what she called the moulds within which poverty grows.

"Planning was chosen as a method to attack the problem of poverty. Poverty is the most degrading experience of human existence-an intensely moral question. Growth by itself does not end poverty, it is the manner in which we plan to grow that matters. Hence in my mind, there is always the question of what is to be done to break the moulds within which poverty grows. Hence our special programmes designed to meet the problems of the poor. The rationale of these programmes is not charity, not providing temporary relief or doles; it is the strengthening of the productive capacity of those who today produce very little. Most of the items of the 20 point programme seek to improve the productive forces and to alter the very contours of our apparatus of production."

Cont...3..

In the process of development, science and technology interact with society, and, occasionally, subgoals can overtake the overall broad goals. It was her conviction that development and modernisation were not complete if a few industries were established or similar schemes were undertaken by establishing other units. She aimed at an attack on the basic problems of society and envisaged to bring about basic changes in the socio-economic structure and the outlook of the people. "Development and modernisation do not consist merely in establishing new industries. They involve basic changes in the economic structure of the nation as well as in the outlook of the people. They imply that we identify the structural weaknesses in society and strive to overcome them. Development is not only an increase in economic production or an addition to the national income; it is a well thought-out programme to ensure that the increased resources are channelled into areas which need care and attention and also ploughed back into activities which ensure further growth. If development does not concern itself with righting old wrongs, future development will itself be endangered". (Address to the Golden Jubilee Session of the Institution of Engineers, Calcutta,, 5 February 1970).

She was fully conscious of the role of science and technology in international affairs. In her address to various international conferences, she emphasised the problem of co-operation among the developing countries; she pointed out the contributions and experimentation that have gone on in different developing countries since they became independent. These countries, in their own way, attempted to utilise science and technology with their own resources through international aid and international collaboration.

Self-reliance and international cooperation were the twin dimensions of her approach to the development of both science and technology and their use in the development of society. Self-reliance, to her, did not mean isolation and trying to do everything by oneself. She believed in collaboration in gaining from others' experience. She felt that with the development of science and technology, there has to be the greatest degree of interdependence. This is evident from her address to the 22nd session of the Economic Commission: "Ours is an inter-dependent world. Can any society today be wholly self-sufficient, whether it is a large or small, developed or developing, and whether it has an agricultural or an industrial economy? The world is one. It is one in hope, it is one in

Cont...4..

prosperity, and it is one in difficulty. The United Nations and its specialised agencies symbolise the oneness of the world." (Inaugural address at the 22nd Session of the Economic Commission for Asia and the Far East, New Delhi, 22 March 1966.)

For Mrs. Gandhi, disarmament and establishment of world peace were key issues impinging on any process of development. Like Jawaharlal, she repeatedly emphasised the importance of establishing peace and creating conditions for disarmament. At the meeting of the non-aligned countries in Delhi. She laid particular emphasis on this point. And just a few months before she was killed, she issued an appeal on behalf of heads of six countries for disarmament and peace.

THESE are some of Mrs. Gandhi's views and objectives. How could one evaluate the contribution of Mrs. Gandhi to the development of the evolution of science policy, its application to the problems of development, in the context of the problems faced by the country, and the initiatives she took at various times? It would be difficult to make a categorical statement because her initiatives, her thinking, and her contributions are so diverse. One must also realise that a world, a suggestion, a statement from her guided scientists to take up numberous projects.

Two major and distinctive contributions are very clear, though. By the time she came to power in 1966, the institutional infrastructure had been fully established and India had produced scientific and technical manpower capable of taking up any challenge.

Cont...5..

INDIRA GANDHI HAD TWO MAJOR OBJECTIVES - TO USE SCIENCE AND TECHNOLOGY TO UPLIFT THE UNDERPRIVILEGED AND TO CREATE A SCIENTIFIC OUTLOOK AMONG PEOPLE

The problem that she faced, and towards which she directed her attention, was one of using the resources which had been built up in the country and giving a direction to scientists' efforts. It was more a question of fixing goals and objectives for them.

So she first looked at the various gaps that existed in the development of the infrastructure and the organisation of research, and then set up institutional infrastructure and the organisation of research, and then set up institutional infrastructure in those areas where a need was felt, such as space, ocean development and environment. She tackled the question of giving direction to scientific development by exhorting Indian scientists to take up the goal of self-reliance as a major element of policy and as a major objective of scientific development. Self-reliance could be interpreted in different ways by different people. She aimed at India's acquiring and developing the capability to take up challenges and to come up with viable answers. One specific area which she repeatedly emphasised and to which she drew the attention of scientists was that of rural development. She put the question squarely before scientists; scientific development towards what end at what cost, and for whose benefit? And she posed the challenge, before them, of taking science and technology to the people, for the benefit of the under-privileged and the rural poor. She repeatedly emphasised that unless Indian scientists were able to solve the problem or rural development, the development and modernisation of the country would remain an unfulfilled goal.

This was her first contribution to science policy. Her initiative and the direction she gave to a series of scientific programmes aimed at solutions of the problems of the underprivileged people and the rural poor. In this context, the 20 point programme sought to link science to the needs of the people.

The second important contribution was in the area of promoting a scientific outlook among the people, or as Jawaharlal Nehru called it, the "promotion of scientific temper". For a society riven by superstition, fossilised tradition and beliefs in the miraculous, the promotion of a new outlook was vital and essential. She repeatedly pointed out to scientists that this was a major task. She also took the bold step of including this in the Constitution of the country; possibly, the Indian Constitution

Cont...6..

is the only one in the world which enjoins upon its citizens a duty to promote social reform and to promote a scientific outlook. This today has become all the more important, since the outlook and atitude that has been generated among the people in the country over the years has led to the politicalisation of religion, and people are cashing in on it by appealing to primitive emotions, outlooks and atitudes.

In a way, it is a failure of scientists. Their limited preoccupation with their professional work and their shying away from social responsibility have created the present situation. Not only have they failed in taking up the challenge of transforming the outlook of the people, but also in creating a faith in them that science and technology would help solve their problem - creating a faith and assurance that their effort would help in removing poverty and illiteracy and give them an opportunity to have a life in which their basic needs would be met and their creative capabilities utilised. It is this failure, on the part of the scientists, which led to the growth of an outlook and attitudes that ultimately felled Mrs. Gandhi. As her life ebbed away, the words of the grand old Latin Poet, Lucretius, in this famous poem, De Rerum Natura, came to mind: "To such evil ends, religion can bring us".

If there is any lesson that we can draw from this tragedy and also from the events that followed, it is that we, the scientists, should take upon ourselves the major responsibility for the two objectives she strived to achieve - to use science and technology specifically for the benefit of the people, and to create in them a new outlook and atitude and give them a hope that they can change their lives through science and technology.

And as we take up this responsibility, let us remember that science is not purely a pursuit of professional work, but a part of total life, of a culture as it had been in those periods when India was in the frontline of creating and promoting science and technology. If we do so, the future is with us.

(Science Today, (March, 1985) pp 49-51)

APPROPRIATE TECHNOLOGY
Essential Medicines in the Third World

By P.F. D'Arcy

For many Third World countries health care is only one problem on a priority scale that is dominated by poverty, starvation, refugees, a growing population, political unrest, and corruption. Furthermore, the type of health care problems in Third World countries is quite different from that in industrialised countries and infectious diseases remain a problem. Despite this high incidence of infectious diseases such countries have only a small share in the total world use of medicines. In the least developed countries spending on drugs per person per year comes to less than US$1, whereas in the industrialised countries the corresponding figure is $70 or more. In many countries this is because imported drugs are too expensive and there are no facilities for the local manufacture of drugs.

If health care is to be given a priority in developing countries, treatment and medication must be available to the sick patient at the time of need. It is a stark fact, however, that throughout most of the Third World almost three quarters of the population has no access to basic health services. Hospitals and clinics are grouped in the major urban areas while most people live in the rural areas and are more or less neglected. Therefore most patients present at hospitals and clinics late, when their disease is advanced. Lack of transport, poor communications, long distances,,and a lack of local medical care may transform simple and curable diseases into chronic, crippling, or life threatening conditions. Drawing up a more equitable health care system, based on the development of primary health care, calls for a firm policy on essential drugs to satisfy the real needs of most of the community. Such a policy is lacking in many countries, and even if patients reach their district hospital the drugs required for their treatment may not be available.

Availability of medicines

In this article I propose to question why "not available" is the most common answer to a request for even simple medicines, and why so many patients in the Third World are deprived of the benefits of effective treatment. The answer to the question, why not available? is difficult because usually various factors have to be considered and these may include inefficiency and corruption. In my experience common explanations why particular drugs or formulations were not available include:

Cont...8..

(1) Because they are too expensive and insufficient funds are available to maintain a constant supply.

(2) Because they are in the central store but transport is not available to distribute them to clinics and hospitals.

(3) Because the government has a foreign exchange problem and the annual drug tender has been delayed.

(4) Because they are held up at the railway station, docks, airport, etc.

(5) Because they have been lost (pilfered) in transit.

(6) Because the papers (import documents, customs clearance certificates, etc) have been lost.

(7) Because they have deteriorated in the central drug store (heat, damp, etc).

(8) Because the replacement supply was not ordered in time. The list continues ad infinitum.

Essential drugs

What, therefore, is the solution? First and foremost, the ministry of health in the developing country needs to integrate a programme of importation of drugs (or their local manufacture if possible) within a coherent policy on primary health care. This requires political stability because such programmes must be long term; it also assumes that health care budgets are given adequate priority. Importation of drugs should be through a regular drug tender, and substantial saving may be achieved by purchasing generic preparations rather than branded or proprietary products. The move among some major pharmaceutical companies to manufacture generic products is particularly welcome, because it increases their availability and allays anxiety about their quality.

Selection of drugs should be based on the model list of essential drugs of the World Health Organisation (WHO), which may be modified or augmented according to the specific needs of the country. Whenever possible, priority should be given in the drug tender to locally based pharmaceutical industries, which should be encouraged to manufacture formulations based on the list of essential drugs. The responsibility for quality control should rest with a government laboratory which

Cont...9..

can ensure that preparations manufactured locally and imported products or raw materials are of a satisfactory standard. Setting up a quality control laboratory may, however, be difficult in small countries which lack the necessary financial, physical, and trained resources, and with these countries in mind the WHO drug certification scheme has been introduced to ensure that imported drugs conform to international standards. Use of this scheme might be combined with more efficient use of the quality control laboratories that are already established, some of which have been set up on a cooperative regional or subregional basis.

Offers of help

Information and guidance on the procedures concerned in obtaining drugs are given by the International Federation of Pharmaceutical Manufacturers Associations (IFPMA). This organisation covers both the developed and the developing world, and its member associations include not only the 100 or so international, research based pharmaceutical companies but also many thousands of small national manufacturing companies producing standards products. The International Federation has taken an active interest in the WHO action programme on essential drugs and, through its international code of pharmaceutical marketing practices, it has done much to counteract the claim by some Third World countries that they are the dumping ground for unwanted, obsolete, and poor quality drugs. IFPMA also provides, advises, and runs training courses on topics such as the distribution and procurement of drugs. In addition, courses in quality control of drugs are arranged for trainees from government laboratories and inspection services in the Third World.

Many Third World countries claim that they are not supplied with information about indications, contraindications, and side effects of individual drugs. In response to this, the International Federation has offered to supply (free of charge to government health departments) standard compendia listing this sort of information - for example, the Physician's Desk Reference (USA), the Association of the British Pharmaceutical Industry's Data Sheet Compendium (UK), the Rote List (Federal Republic of Germany), and the Dictionnaire Vidal (France). The problem remains, however, that owing to bureaucratic inertia or inefficiency the information contained in these compendia is not always passed on by the health ministry to the practitioners who need it.

Cont...10..

Local drug manufacture

The United Nations Industrial Development Organisation (UNIDO) is concerned with helping developing countries to industrialise, and the manufacture of pharmaceuticals is one of the industries that they have singled out for special attention. The United Nations Conference on Trade and Development (UNCTAD) has been negotiating an international code of conduct on the transfer of technology, and an agreement by which local manufacturers may gain technical know how from the larger international companies. The WHO, and the World Bank - or in some cases regional development banks - are already collaborating in several industrial projects. Clearly if a group of countries got together and agreed to have a single commercial production unit for essential drugs this would count as technical cooperation between developing countries and would attract grants and funding, which is one of the priorities within the United Nations system.

Unfortunately, the development of a locally based pharmaceutical industry does not have priority in some Third World countries, simply because the government is more interested in providing employment in more labour intensive industries, with a predominance of unskilled or semi-skilled jobs. The pharmaceutical industry is not labour intensive and depends largely on a small core of local or expatriate skilled staff. Nevertheless, a local pharmaceutical industry is an important contribution to the overall provision of health care and must be recognised as such, although it does not necessarily produce cheap drugs, nor does the manufacture of essential drug preparations tend to attract large profits. Thus the local industry needs to be protected by concessions to facilitate the import of raw materials, containers, and packaging materials. It is reasonable to expect such concessions provided that the companies are manufacturing essential drugs with a view to improving health care and not producing non-essential proprietary preparations or cosmetics.

Storage and distribution

Even if an adequate supply is ensured there may still be problems of storage and distribution, especially if supplies are centralised in a government drug store. Road and rail system in developing countries are often poor, so that the distribution of consumable items from urban to rural areas suffers. Medicines should, however, be given priority and not regarded as ordinary items of commerce.

Cont...11..

Whereas the role of the medical practitioner is traditionally appreciated and understood in all Third World countries (particularly in the governmental administrative service), that of his pharmaceutical counterpart is less well understood. Many countries fail to understand that expert pharmaceutical advice is essential not only for drug procurement but also for effective storage, distribution, and legislative control. Many countries rely on inadequately trained dispensers to staff hospital pharmacies, on store keepers to control distribution of drugs from central stores, and on doctors or administrators to control their drug tenders. This is wasteful, and it fails to take account of the skill of the pharmacist and the benefits that can accrue from having expert pharmaceutical advice about the ordering, quality testing, storage, distribution, and supply of medicines.

Hospital manufacture

Local manufacture of pharmaceuticals invariably thought of as a commercial enterprise, but a lot can be done in the hospital pharmacy provided that expert advice and skills together with the necessary equipment are available. The range of equipment required will depend on which preparations are manufactured, but this need not be extensive. Advice on the choice of equipment, and subsequent servicing, may be obtained from the Third World project of the Federation Internationale Pharmaceutique.

Producing a hospital formulary of essential drugs may cut the hospital's total drug bill, and the manufacture of simple solid and liquid oral dosage forms, topical preparations, injection solutions, and sterile eye preparations may not only save money but also ensure that these preparations are readily available and that they can be freshly prepared according to demand. A formulary - for example, one based on the British National Formulary - will also do much to standardise treatments and prevent the prescription of unnecessary preparations.

Containers

Suitable containers for dispensed medicines do not exist in many developing countries. Tablets are dispensed in a screw of papers; liquid formulations are filled into Pepsi Cola bottles; sterile eye ointments are spread on to paper and given to the patient as a crude package; sterile eye drops or

Cont...12..

lotions are put into cans, bottles, tins, or whatever container the patient can buy at the stall at the entrance to the hospital. Thus the Third World urgently needs an inexhaustible supply of simple plastic universal containers that may be sealed and made air and water tight. Clearly, there is little use in dispensing essential medicines if they are spoilt or allowed to deteriorate almost immediately in unsuitable containers. It would be better to allocate a part of the budget for outpatients' drugs to providing cheap and simple containers. At least one manufacturer in each country should be encouraged to produce a standard container for outpatient use. It has been done for yogurt in some Third World countries, so why not for medicines? It may then be possible to write simple instructions (or draw pictorial labels) on the containers so that the patient uses the medicine correctly. It is practically impossible to write instructions on a screw of paper - I know, I've tried.

(British Medical Journal, 289, (13 October, 1984) pp.982-84)

INDUSTRIAL RESEARCH AND DEVELOPMENT IN AUSTRALIA

By M. CHANDRA

Australia is one of the few developed nations of the southern hemisphere, with most of its neighbours as developing countries. The continent has vast natural resources, especially of a variety of minerals, and it is one of the few OECD (Organisation for Economic Cooperation and Development) member countries with the status of a net exporter of energy. Though a rich industrialized country, Australia has certain characteristics of the developing countries. Besides being basically a supplier of primary products, it relies heavily on overseas science and technology in most of the inustrial fields.

Though achievements entirely of Australian origin have been significant in the developmental process, specially in agriculture, much of Australia's scientific and technological effort has been devoted to successful adaptation of overseas science and technology to its needs. However, some fields have attracted a greater measure of support and interest than others, either because of their economic importance, as in the case of agriculture and mineral processing, or because of the advantages that Australia has owing to its geographic position, as in areas like astronomy of the Southern hemisphere, Antarctic research is organized in Australia owes much to the government structure of the country, its geographic isolation, and its topographical and climatic characteristics.

Trends in Industrial Research and Development (IR&D)

A study of the development of Australian Science and Technology (S&T) makes evident three interesting trends: (i) strong governmental influence in all fields of S&T, (ii) dominance of biological sciences in R&D, specially by private industry.

The importance of primary industry to the Australian economy in the beginning of the century, and the geographical limitations of the country, provided a natural stimulus for the encouragement of agricultural and biological sciences. A consequence of this has been the dominance of the two areas in R & D, a trend that continues. On the other hand, manufacturing industry in Australia has been a post-World War II phenomenon (as it has been with most of the developing countries including India) and had developed with an "import replacement strategy" which, however, encouraged

Cont...14..

importation of technology by the industry. This strategy was responsible for the development of a fairly rigid attitude on the part of industry and government against the need for in-country development of new ideas or products, which led to a continual underplaying of IR&D. Though Australian Industry at times has recognized the value of IR&D, it has by and large been reluctant to take financial risks. In fact, certain characteristics of Australian economy, viz. the smallness of her domestic market, high transport costs and wages and the country's relative geographic isolation, had contributed to magnify the risks perceived by the industries. Comparison of relevant expenditure data for Australia with those of two highly industrialized countries, viz. UK and USA (Table 1) shows clearly the inadequacy of IR'D activity.

Table 1 - Expeenditures on R&D in Australia, UK and USA

Country	GERD / GDP %	GPRD / GDP %	GFRD / GDP %
Australia	0.9	0.48	0.64
U.K.	2.1	0.57	1.09
U.S.A.	2.3	0.38	1.25

GDP: Gross domestic product; GERD: Gross expenditure on R&D. GPRD: Government performed R&D; and GFRD: Government funded R&D.

Source: Search, 12(1981),386.

GPRD/GDP data in Table 1 show that relative to Australia, this figure is 20% higher in UK and 20% lower in USA. Australian government's performance level is thus by no means excessive for its small economy, and GFRD/GDP data show that government funded (as distinct from government performed) R&D is 70% higher in UK and 95% higher in USA. (It is, however, to be pointed out that such comparisons are often not justified, as spending may be high in certain specific areas, for example, defence, in certain countries). The difference between GERD/GDP and GFRD/GDP gives a reasonable measure of industry funded R&D, and it is here that a great difference emerges between Australia, UK and USA. This small contribution by industries takes Australia towards the bottom of the OECD nations in terms of GERD, though the country actually is a middle ranking OECD nation in terms of government expenditure on R&D. (It is worth mentioning here, by way of comparison, that in India, a country which along with Australia is often grouped as a

Cont...15..

middle level country in terms of scientific enterprises, the total R&D expenditure as percentage of gross national product is 0.6, while in Australia it is 1.0. The total productive industrial sector contributes 25% of India's R&D expenditure, while in Australia this contribution is about 21%). A survey made as early as 1970 had revealed that Australian industries, specially the ones requiring low capital investment, are quick to learn, adapt and diffuse imported technology, while in the case of technology requiring high or medium capital investment, the Australian industry is slower than the industries of the most advanced countries in the initial use of such technology.

Why the Trend of Technology Importation

Many factors are responsible for this trend of "importation of technology". One of the more important ones is that one third of the Australian manufacturing industry is wholly owned by overseas firms, and therefore generally imports most of its expertise and innovation from the parent organisations. Coupled to this factor are Australia's small and scattered domestic market, distance from foreign markets, higher wage structure in comparison to neighbouring countries, competitive pressure to reduce operating costs, etc. All these factors tend to restrict the availability of internal funds for R&D by firms. Further, the trend of transfer of governmental research funds to the private manufacturing sector through contracting has been insubstantial in Australia.

On the managerial side, the Australian industry managers, by and large, seem to be reluctant to take financial risks for conducting IR&D, even if they recognize its potential value. This fundamental conservatism of Australian managers and investors has turned out to be an obstacle to technological changes. Since only a very small percentage of manufacturing concerns conducts IR&D because of lack of appropriately qualified staff, the manufacturers are often disadvantaged even to interpret research results. Small firms also have the added problems of limited access to risk capital as well as to technological know-how and skills that exist in the governmental R&D sector. Thus, there seems to exist in Australia the need for improving liaison between industry, the government departments, the CSIRO (Commonwealth Scientific and Industrial Research Organisation, Australia) and the teritiary education sector - the principal bodies involved in R&D. Also, unlike in the rural industries of Australia, no comparable infrastructure of research and technical liaison agencies has evolved in relation to manufacturing industry, including mining. The dependence on foreign technology was generally accepted

Cont...16..

within the governmental and policy making set-up, which had in fact encouraged industrial innovation through direct foreign investment.

The present Australian government has, however, from a critical review of the Australian IR&D position, realized that one of the reasons why the per capita GDP of a resource-rich country like Australia has changed unfavourably compared to those of resource-poor countries like Japan, the Netherlands and Sweden is due to the latter group's "intellectual inputs" (in industries) - invention, research and development, product innovation, design, patent, royalities and copyright - which Australia lacks at this stage. Thus, whereas the Australian scientists produce about 2% of world scientific knowledge, they are responsible for only 0.7% of world patents, on which technical innovation is based. Australia has also realized that it needs to diversity its industrial activities away from the traditional industries and has to move rapidly into the industries of the future, such as biotechnology, computer software and chips, scientific instrumentation, precision engineering, lasers, communication technology etc.

"Sunrise Industries"

The government has recognised that to thriven in this competitive world, as a matter of urgency, Australia must develop high technology "sunrise industries" as wealth generators, which should also compensate for long-term decline in employment in the traditional manufacturing industries. As a first step, this will mean building up of a technological base, with special attention to R&D S&T manpower development and commercialization of research. The current government sees the need for the multinational corporations to act for the enhancement of Australia's technological strengths as well as governmental intervention in the processes of technology transfer to ensure that Australia gets the best deal. The government realizes that it is important for the country not to repeat the mistakes of the past by concentrating too many resources within the Government sector. In addition, it sees the need to place greater emphasis on encouraging industries to develop, commercialize and market the results of their successful research. The government on its part plans to assist the industries by making effective incentives available. The present government recognizes the country's poor record in product development and commercialization, as well as the fact that years of protection against imports have dulled the country's "intrepreneurial sprit" The Government also realizes the need for high technology not just to promote high technology

Cont...17..

itself, but to use it as a vanguard for the restructuring of the entire Australian economy towards an information society and information economy that it hopes will emerge in the future.

Keeping all these factors in view, the Australian Labour Party's S&T policy has identified 16 "sunrise industries industries", which fall into two categories: (i) areas where Australia has a leading edge in research and where international market seems likely, e.g.biotechnology, solar energy, industrial ceramics, custom designed chips, and (ii) areas where Australia would itself provide a major market,e.g. personal computers and communications technology. Of all these "sunrise industries", biotechnology has the greatest potential for wealth creation and here Australia has an advantage in skills - a strong agriculture base and expertise in plant and animal genetics, microbiology, biochemistry and medical research.

However, the concept of "sunrise industries" has not been taken favourably by all Australians, specially the traditional economists, who are of the view that these industries are "technological pipe dreams" and any kind of special assistance to them would necessarily distort allocation of resources, which, in turn, would be detrimental to the well-being of the community as a whole. One suggested way of overcoming at least some of these objections has been for Australia to adopt a "key technology" policy, whereby special assistance is made available to any firm in any industry, provided it adopts selected "key" technologies, such as microelectronics, robotics, biotechnology, etc. With this approach, though the task of selecting "sunrise industries" will be more or less replaced by the task of selecting key technologies, diffusion throughout the economy will be encouraged by allowing the existing industries to benefit - industries which are willing and are able to adopt "key" technologies. The "key technology " approach could be more appropriate from infrastructure considerations as well. Some Australian policy scientists also consider that "sunrise industries" cannot be "injected into" an economy, but that they must grow up out of it.

National Technology Strategy

To discuss this whole issue of IR&D, the government organized a national "summit" conference on technology, under the initiative of the current Australian Minister of Science, in Canberra, in September 1983. As a result, the Australian government is now planning to eastablish

Cont...18..

in their Department of Science and Technology (DST), a new research, development and innovative division which will work with the existing industries or though industry-based committees to encourage them to make an adequate contribution to R&D, either with their own enterprise or by contributing to a common fund.

The "technology summit" had also resulted in a draft "National Technology Strategy" (NTS), which has been distributed for discussion, by the DST, with a view to subsequent adoption by the Government. The document is a complex multilayered one, which sets out policy principles, objectives and long and short term policy actions in relation to 13 heterogeneous set of "sectors" and "concerns". One of the important aims being "promotion of a technology culture in Australia", the NTS envisages roughly doubling of the national R&D efforts by 1995, at the same time redressing the imbalance between public and private sectors as regards R&D performance. To do this, it will be required that the annual R&D expenditure of the industries be increased by $ 1200 million, which is 5-6% of the total business profit. The long-term actions as developed in the document will affect the R&D system in the country as a whole, the most specific long term action being to examine the feasibility of a world product mandate for product development in Australia by foreign owned companies. Three specific short-term actions include: increasing funding for basic research, strengthening the private sector R&D, and increasing the relevance of tertiary institution research to commerce, industry and community. To assist the growth of the private sector R&D, short-term action suggestions include tax incentives, more Australian Industrial Research and Development Incentives Grants (AIRDIG) funding and a programme of transfer of R&D work from the commonwealth to the private sector, the aim being to earmark specifically by 1990 10% R&D funds of commonwealth research organizations for contracting out. One element of the strategy suggested is selective assistance for "key technologies", the latter being defined as those which are vital to the competitive viability of a wide range of industries, including information technology, biotechnology, materials technology and marine science technology.

Organization and Funding of IR&D

Funding of IR&D in Australia is done by a variety of agencies: Commonwealth and state governments, industries, tertiary education establishments, private non-profit organizations, etc. Of these, the government sector is the largest funding body followed by the business enterprise sector.

Cont...19 ..

The main avenue of commonwealth governmental support to IR&D has been the AIRDIG set up originally in 1967 under an act, to encourage IR&D. Reviewed in 1973, the act now provides funds through two types of grants; general and selective. The basic objectives are to develop and use Australia's physical resources, to expand exports, to restrict imports, to increase productivity and to develop Australian economy conducive to the defence of the country. Though the acts were intended to stimulate IR&D in Australia, the success so far has been rather negligible. One of the main reasons for failure appears to be inadequate level of funding, which has neither provided real incentives to Australian industries nor encouraged industries to put in concerted efforts and funds for adequate development. Inadequacy in communication and liaison between government and industry, and deficiencies in managerial attitudes in the industries seem to be additional deterrents.

Conclusion

The trend of technical development in Australia has been almost entirely a matter of competent importation of technology-largely independent of Australia's scientific efforts; the function of IR&D has been mainly to help technological importation by identifying significant overseas developments, and to help the industry select and adapt this technology to best suit the local needs.

Successful importation of technology has been possible because Australia has consciously created a well developed scientific and technical infrastructure supported by a scientifically literate community, which can understand, evaluate, adapt and adopt overseas developments in an atmosphere suited to this. The policy has also been to encourage direct and personal involvement of scientists in such acquisition and adaptation. Skills in these functions have thus been taken in Australia to be at least as important in industry as scientific and technological activities themselves. At present, Australia is a net importer of technology, except through its programmes of providing aid to developing countries, when it acts as an exporter of technology. Thus, as far as IR&D is concerned, Australia appears to be like a "developing country" needing access to science and technology via r research, information and results from other parts of the world.

(Journal of Scientific and Industrial Research, 43, 9(Sep.1984) pp 465-468)

GUEST EVALUATION
Seven Years After the 1977 UN Conference on Desertification: Lessons Learned or To Be Learned

By Mohamed Kassas

Introduction: The Plan

The United Nations Conference on Desertification (UNCOD), which was held in Nairobi, Kenya, during 29 August-9 September 1977, adopted a plan of Action to Combat Desertification (hereinafter referred to as The Plan of PACD). It presents a set of recommendations for initiating and sustaining efforts on the scale required to halt further deterioration of productive lands that are prone to desertification. The draft plan, as submit to the Conference, was based on a synthesis of available scientific knowledge formulated in a series of state-of-the art documents.

The emergent plan, though comprising numerous parts ('Recommendations'), was foreseen as being implemented in its totality. In one dimension it integrated three principal operational functions: (1) monitoring and assessment of desertification hazards and of the resource-potential of threatened lands; (2) planning for programmes that aim at arresting the advance of desertification, while reclaiming desertified land and developing the resources of these territories as integral parts of national plans for development; and (3) implementation of these programmes through adaptation and application of existing scientific and technological knowledge.

In another dimension, The Plan conceives (a) that combatment of desertification at the field level is primarily a national operation; (b) that desertification hazards often transcend national boundaries, and so are systems of natural resources-hence the special importance of regional collaborative action; and (c) that desertification calls for global solidarity and world-wide actions.

The Plan in the form 'adopted as amended' by the UN Conference on Desertification, may seem too widely comprehensive to be practicable. This relates to two aspects. The first of these is that the authors of the draft plan designed it to suit the variety of ecological and socio-ecomomic situations that prevail in some 90 countries which face hazards of desertification: it was hoped that each country would derive, from the detailed directives of The Plan, materials for designing a national plan of action to combat desertification, and that such national documents would lead directly to operational programmes. The second

Cont...21..

aspect was that delegates at the Conference added bits and pieces to address specific issues.

These additions further expanded the broad scope of The Plan without, however, undermining its solid structure. For instance, PACD called for the preparation, publication, and distribution, of a world desertification map at a scale of 1:5,000,000; it also recommended a series of actions, including the holding of regional seminars on desertification issues, and actions on 'the combination of industrialization with the development of agriculture and their effects on the ecology in arid areas'.

Implementation

The Plan envisages that its implementation is ' 'expected to be carried out by governments through their national institutions', and hence recommends the creation and development of national bodies and machineries that would be capable of implementing national plans and the provision-from national resources or with aid support-of the human and material resources needed for the effective operation of the national machinery. National programmes seek to reach three principal objectives: (1)to arrest desertification processes, (2) to establish ecologically sound land-use practices that ensure sustained productivity and (3) to provide for social and economic advancement of the human communities concerned.

But action at the national level was-in general-far from being effective. The countries that are worst affected are the Third World countries in tropical drylands and adjoining sub-humid territories. These are countries which are disadvantaged climatically (e.g. with recurrent droughts) and economically (e.g. being low-income countries), and are often beset by political unrest. Moreover, desertification-control projects do not seem capable of competing for the limited financial resources that are available; their rates of economic return are often lower, and their gestation periods are often longer, when compared with other 'marketable' projects. With these constraints, countries seem unable to accord priority to desertification control programmes within their plans for investment of all-too-scarce cash and capabilities.

For regional cooperative action the Conference (UNCOD) and The Plan (PACD) considered and endorsed three principal modalities: (1) implementation of transnational projects outlined in six feasibility studies on regional action related to (a) major regional aquifers in north-east Africa and (b) the Arbian Peninsula, (c) green-belt

Cont...22..

establishment in north Africa and (d) the Sudano-Sahelian countries, (e) regional monitoring of desertification and arid-land resources in south-west Asia and (f) South America.

The other principal modalities endorsed by UNCOD were (2) establishment of regional research and training centres and (3) implementation of regional plans for combating desertification, which might include regional networks of Biosphere Reserves. Of all this, lamentably little has been achieved. Strained political relationships amongst concerned countries prevented the full implementation of these projects and the initiation of similar cooperative schemes in other regions. In some instances, total lack of any competent regional machineries, that should have set combatment of desertification among their priority functions, was behind the failure to initiate suitable action.

There were, however, some positive aspects of regional and international efforts in the Sudano-Sahelian region, including UN and Club-du-Sahel programmes of aid, but these were not commensurate with the ecological hazards that were accentuated by recurrent drought.

At the international level, the UN General Assembly has kept the issue of desertification and the implementation of The Plan on its agenda of every session since 1977. The General Assembly has repeated its strong plea for greater efforts to combat desertification, and for more effective national and international endeavour. The cries have been loud but the echoes less audible, although productive lands were being lost by millions of hectares every year.

Economic Issues

Considered in its broad aspect, desertification is the ecological degradation that reduces the productivity of land and hence undermines the life support systems for a great number of people-in arid and semi-arid territories of the world. It results from excessive pressures of use on inherently fragile ecosystems-commonly in areas of low rainfall, long dry seasons, recurrent droughts, mobile surface deposits, skeletal soils, and/or a thin and fragile natural plant cover. Combatment of desertification combines curative and preventive measures: rehabilitation of degraded lands, introduction of conservation measures, and ecologically sound systems of resource management.

Actions for combating desertification are inseparable from actions of resource development and management in arid and semi-arid lands. It should be realized, however, that anti-desertification projects often entail gestation periods

Cont...23..

that are longer than those normally involved in development scenarios, while the cost-effectiveness of these projects is often non-competitive on a financial basis.

Schemes that aim: at checking land-degradation in pasture-lands, rain-fed farmlands, and irrigated agricultural lands; at sand-dune stabilization; at establishing large-scale green belts; at introduction of soil and water conservation systems in resource mangement; or at reclaiming new territories of arid and semi-arid lands, are apt to be costly, while projects involving irrigation schemes are particularly expensive. Indeed such projects are commonly non-competitive by prevalent market values, at least when compared with present rates of interest. Investment in land-reclamation projects commonly do not pay well financially.

It may be remembered that agriculture in well-established farmland in temperate countries (e.g. countries of western Europe) has become increasingly dependent on government subsidy. Government-subsidized ventures have social functions that relate to societal needs (in this case, satisfaction of basic needs for food). This shift towards social-service activities rather than commerically feasible ventures, relates mainly to costs of capital investment in land-reclamation projects, and only partly to the running expenses of farming. National policies (and policies of aid-institutions) should recognize this situation and develop practices of operation that accommodate it.

In a Study on Financing the UN Plan of Action to Combat Desertification (United Nations document A/35/396-17, New York, NY, USA: 128 pp., 1980), estimates are given of the cost of restoring the productivity of 100% of the affected irrigated farmlands, 70% of the affected rain-fed croplands, and 50% of the affected rangelands. The average annual cost of such a programme would be in excess of 2.4 thousand million US dollars, to be sustained for 20 years. The total external assistance involving desertification control was estimated in 1978 at about 600 million dollors annually, leaving a requirement from additional sources of about 1.8 thousand million US dollars annually for the balance of 20 years from 1978.

It is thus painfully evident that (1) available aid sources are woefully short, and (2) available domestic sources fail to provide priority to anti-desertification projects. Innovative means for financing such projects need to be explored. Such means might well combine aid-grants with commercial loans, which combination would soften the impact of the loans and, hopefully, make their investment in anti-desertification programmes acceptable to national

Cont...24..

plans of development. A 1982 United Nations study describes the feasibility of a public international corporation that would attract investments and collect aid-grants and, from their combination, provide financing for anti-desertification projects with non-commercial rates of return. This concept is worthy of further elaboration, and should involve exploring alternative options for such combinations of aid-grants and commercial loans.

Means of land-reclamation and combating desertification that depend on labourmmay be more feasible than those depending on capital. This may require mobilization of community support and, before that, effective programmes of education.

Societal Issues

In the past, many of the measures that aimed at arresting desertification failed to meet with the success which their sound technological bases promised, because they lacked community participation and support. This realization underlines the special importance of setting and implementing government policies that provide appropriate mechanisms, incentives, and education programmes, which are needed for: the acceptance and implementation of measures at community level, their maintenance within improved and productive land-use systems, and eventually their self-generation towards achievement of imporoved living-conditions. These policies should secure community involvement in determining priorities, and in the planning and implementation of combative measures. Through such involvement, jeopardization of dryland communities-particularly of the rural poor who are both the cause and the victims of desertification-should be removed or anyway relieved.

Demographic patterns, including nomadism, that prevail in arid lands and desertification-prone territories, may not be conducive to effective public participation. Settlement of nomads may not be the answer-except within the framework of transformations of land-use systems, developmer development of land resources, and changes in land-tenure systems. For community participation to be effective, societal instruments (legislations, institutions, means of mobilizing public support etc.) may need to be developed Education in its broad sense should be supportive of such enlightened development.

It is evident that active implementation of anti-desertification programmes is hindered by a complex of constraints. Thus government policies do not seem to accord

Cont...25..

at all high priority to such programmes, which indicates the light political weight of the communities that are directly affected by desertification, and hence their inability to have their concerns set in their rightful position of priority. As desertification further undermines the life-support systems of such communities, they are further 'jeopardized' or 'Marginalized', and often opt to move towards urban centres. Further constraints include organizational ones relating to lack of national machineries that have desertification control as their principal function, and shortages of trained manpower. It is important to remember that scientific knowledge and available technical means need to be suitable for, and when necessary adapted to suit,,local ecological and social conditions.

Actions Needed or Suggested

National policies for control of desertification need to be formulated and endorsed. These policies should accord priority to the sustenance of productivity of arid lands and the adjoining sub-humid territories, and to the well-being of human communities in these areas and als of their life-support systems.

There is need for an integrated packet of national policies and actions that combine the following.

1) The giving of much higher priority than at present, in national plans for development, to actions and programmes to combat desertification;

2) The establishment of national machinery for combating desertification, duly provided with the capacity to coordinate national endeavour, to remove constraints that hinder action, and to carry out basic functions related to policy and planning as well as due monitoring and assessment;

3) The creation of conditions and institutions that promote participation of rural populations affected by desertification hazards;

4) Vast increases in funds and resources apportioned to desertification control programmes, so emphasizing the need for additional means that flow in at sustained rates; and

5) The institution of programmes of research, and of training of technicians as well as managers.

Cont...26..

Programmes addressing the need for ensuring public participation and mobilization of public support will require a variety of actions, including:

- Educational programmes and Media Programmes
- Extension services and demonstrations;
- Promotion of non-governmental organizations; and
- Creation of institutional arrangements (cooperatives, rural clubs, etc.) with the support of governments.

Reviewing examples of success and of failure in desert combatment, we note the value of, and dire need for, regional cooperation. Desertification hazards are often transboundary, but transnational joint action at field level is often jeopardized by strained political relationships. One modality that may avoid such difficulty is to develop regional networks of national components: the WMO/UNSO programme of Applied Agrometeorology and Hydrometeorology in the Sahel countries, now extended to cover the Sudano-Sahelian region, is an example of success. This model could with advantage be simulated in:

a) regional networks of sand-dune stabilization,

b) regional networks on reafforestation, and

c) regional networks of research institutions and training centres.

(Environmental Conservation, 11,3 (Autumn 1984) pp 195-197)

Steroid Hormone Systems Found in Yeast

Sex Steroids and Corticosteroids in Yeasts may Explain their Pathogenicity and Yield Clues to the Evolution and Function of Hormones

By Gina Kolata

David Feldman, who is chief of endocrinology at Stanford University School of Medicine, has spent most of his career studying steroid hormones in humans. But a few years ago he sat in his backyard with his colleagues and discussed how far back in evolution mammalianlike steroid hormones and receptors might go. "People kept looking at simpler and simpler organisms (and finding hormones and receptors)," Feldman noted. "But they went in small jumps - to amphibia or sharks. We felt it was worthwhile to make a big leap back and look for mammalian-like steroid receptors and hormones in really simple organisms."

Since there was already evidence for yeast peptide hormones, Feldman and his colleagues decided to look for steroid hormones and receptors in Candida, a well-studied yeast that frequently infects people, especially when their immune systems are suppressed. Working with David Loose, a graduate student, Feldman and David Schurman, an orthopedist at Stanford who is interested in joint infections, looked first for the receptors. "To our amazement, we found a binding site for corticosteroids, that looked somewhat like the receptors we see all the time in mammalian cells," Feldman recalls. "We got very excited and we asked, "What is it there for ? They must have something like a hormone as well."

Now Feldman and his associates have discovered what appear to be mammalian-like receptors and steroid hormones in at least three different species of yeast - a finding that has implications for the understanding of what hormones do and how hormone systems evolved as well as possibly for the treatment of fungal infections, since some of these yeasts are pathogenic. It also fits in well with recent, and independently developed, finding by Jesse Roth of the National Institutes of Health and others that peptide hormones, such as insulin, are widespread, occurring even in bacteria (Science, 12 March 1982, p.1383).

The first thing that the Stanford researchers point out is that these are not hormones in the usual sense of the word. Ordinarily, endocrinologists define a hormone as a substance that is produced in one part of the body and acts on cells elsewhere - a chemical messenger within an animal. Since yeasts are single-celled organisms and since these hormone-like substances are also found in the medium that surrounds them, the "hormones"

Cont...28..

are acting more like pheromones. It is well known that peptide hormones, unique to yeast, are critical for mating. But what is extraordinary is that these simple single-celled organisms and humans make chemical messengers that can bind to each other's receptors. For example, Candida not only has receptors that bind glucocorticoids, but it also makes a substance that both competes for the Candida receptors and binds to mammalian glucocorticoid receptors.

Feldman is particularly intrigued by their most recent finding. When he and his associates at Stanford and at Syntex Corporation looked at Saccharomyces, the common bakers' and brewers' yeast, they found that it has receptors that bind estrogens, although it does not have glucocorticoid receptors. Very recently, they found that it actually produces the human female sex hormone 17B-estradiol. "This is the one time that we believe we have finally identified the hormone in the yeast," Feldman remarks, "The starting thing is that it is identical to the human hormone." This discovery raises the possibility that people may be ingesting small quantities of estrogen when they drink alcoholic beverages, Feldman notes.

In further studies, Feldman, Loose, and E. Price Stover of Stanford colleagues David Stevens, who is chief of infectious diseases at Santa Clara Valley Medical Center, and Angela Restrepo of the Corporacion De Investigaciones Biologicas in Medellin, Colombia, to look for steroid hormone receptors in the pathogenic yeast Paracoccidioides brasiliensis. The organism, they find, has estrogen receptors.

The most immediate clinical implication of this work is a new understanding of the pathogenicity of P. brasiliensis. This yeast, which causes a devastating disease in South America, infects about 75 men for every woman. At first, researchers explained this unusual sex ratio by saying that the men worked in the fields where they inhale the organism. But Restrepo established that men and women have equal contact with the fungus. Because of their work with the other yeasts, the Stanford scientists suspected that the organism might prefer men because it has sex hormone receptors that bind these hormones and recognize sex steroids. The hormonal environment of the host might determine the ability of the fungus to cause the infection.

Stevens cultured the organism, which is a biohazard, and the researchers looked for male and female sex hormone receptors. They found no androgen receptors but did identify estrogen receptors. Then Restrepo discovered that estrogens inhibit the conversion of the mycelial form of the organism, the form that is inhaled, to the yeast form of the fungus that produces the infection. Although the investigators have not yet looked to see if P. brasiliensis makes its own estrogenlike hormones, they expect that it does and, says Feldman, "We presume that the organism's own hormone regulates its conversion from mycelia to yeast."

Cont...29..

At least one other fungus may also have its growth regulated by steroid hormones of its host. David Drutz and his colleagues at the University of Texas in San Antonio have found sex hormone receptors in the pathogenic yeast Coccidioides immitis, which infects people in the southwestern United States, causing as many as 25,000 to 100,000 new infections each year. The yeast infection seems to disseminate more frequently in pregnant women, which may be an indication that its growth is affected by its host's hormonal environment.

Another aspect of this story involves a drug used to treat fungal infections. Allan Pont, who is now at Children's Hospital in San Francisco, Stevens, Feldman, and others have found that the antifungal drug ketoconazole inhibits the production of steroid hormones, including both cortisol and testosterone. Testosterone inhibition may account for one rare side effect of the drug - the growth of breast tissue in men. Pont, Stevens, and others then decided that they may be able to exploit this effect of the drug by using it in higher doses to treat prostate cancer - a condition in which it is beneficial to suppress the production of testosterone.

Then Feldman, Stover, and Loose looked to see if ketoconazole also binds to and blocks human glucocorticoid receptors. They found that it does. Because ketoconazole both inhibits cortisol production and blocks its action at the receptor, the Stanford researchers speculate that the drug may be useful as a glucocorticoid antagonist. Work with ketoconazole helped Feldman, Lee Wagner, Paul White, and other Stanford colleagues to understand the side effects of etomidate - an anesthetic that is an analog of ketoconazole. Because of etomidate's structure, they suspected that it too might interfere with steroid hormone production. They found that it, like ketoconazole, blocks the production of corticosteroids, a discovery that is of practical importance.

Etomidate is frequently used in Europe as a sedative, particularly for patients on respirators in intensive care units. But the use of this drug has been associated with an unexpectedly high mortality rate in the critical care setting. Feldman and his associates suggest that the explanation is etomidate's suppression of cortisol production. "The one thing you don't want to do is remove cortisol from people under stress," he says.

Cont...30..

But, for basic scientists, the most interesting question about these yeast hormone systems is the one that is still unanswered: What is the physiological function of steroid hormones in yeast? The three yeasts that Feldman and his colleagues have studied are very similar evolutionarily, yet only Candida makes a corticosteroid-like substance, Paracoccidioides brasiliensis responds to estrogen and Saccharomyces makes estrogen. The two most likely possibilities are that the yeast use these hormone systems to communicate about sex or about food. Still, as Feldman points out, "we haven't proved that these are really hormones and receptors until we show a function."

(Science, 225, 4665 (August 1984) pp. 913-14)

Controlling the Body Geometric

By Julie Ann Miller

What forces shape an organism as it develops from a single cell into a fly, a chicken, or a person? Similar embryonic structures give rise to adult parts as different as the head and abdominal segments of a fly. For many years researchers have had evidence that this development of body shape is genetically controlled. Mutations in certain genes, called homeotic genes and, so far, identified only in insects, can make a fly segment develop as if it were following the plans of some other segment. The result can be bizarre: a fly with two sets of wings instead of one or with legs where antennae should be

Recent research on these insect homeotic mutants has unexpectedly given biologists a clue to the embryonic development of a wide variety of other organisms. A segment of DNA associated primarily with fruit fly homeotic genes has now been identified in several organisms, including earthworms, frogs, chickens, and humans. This segment is likely associated with genes that play a crucial role controlling development in each of these animals.

All six species of segmented animals and vertebrates examined so far have genes containing a stretch of DNA closely related to a segment shared by homeotic genes of the fruit fly Drosophila melanogaster. This stretch of DNA encodes a chain of 60 amino acids. Geneticists speculate that this gene fragment represents a portion of a protein that binds to DNA. Such a protein could turn other genes on or off, thereby controlling aspects of development.

Geneticists Walter J. Gehring and colleagues at the University of Basel, Switzerland, have dubbed the region shared by homeotic genes " he homeo box." Drosophila has two major groups of homeotic genes, and the homeo box has now been identified in several genes of each complex as well as in a few genes of unknown function elsewhere. Several research groups have determined exact nucleotide sequences of homeo boxes in the fruit fly. Although they are not identical, any two of these segments share more than 75% of their nucleotide sequences.

What is the function of homeo boxes? Allen Laughon and Matthew P. Scott of the University of Colorado at Boulder recently reported in Nature (310: 25-31) that homeo boxes are likely to encode parts of DNA-binding proteins; part of the homeo box encodes a protein region similar to those of some bacterial proteins that bind to specific DNA sequences. The rest of the homeo box encodes a sequence suggestive of non-specific DNA or RNA binding.

Cont...32..

In the same issue of Nature (pages 70-71), Gehring and colleagues reported a comparison between the amino acid sequence coded by the homeo box and more than 2000 protein sequences in a computer data bank. They found the greatest similarities between the homeo box and the yeast alphal and alpha2 mating type proteins. These yeast proteins control the expression of many mating genes and possibly that of genes regulating a form of cell differentiation. Gehring and colleagues say, "It is remarkable that the yeast mating type genes should have been found to have homologies with these Drosophila homeotic genes because both are among the very few genes known to control the stable determination of cell types."

The Basel scientists have also used radioactively labeled DNA segments to discover genes related to homeotic gene in several different organisms. The labeled segments bind to the DNA of another organism wherever they encounter a sequence similar to the homeo box. In the June 1984 Cell (37: 403-408). William McGinnis and colleagues report such binding to a few DNA sequences in each of three segmented invertebrates - an earthworm, a beetle, and another species of fruit fly.

A sequence resembling the homeo box has also been detected in all vertebrate species examined so far: frogs, chickens, mice, and humans. The scientists point out that the basic organization of the vertebrate skeleton, nervous system, and muscle arises from a reiterated embryonic structure, the somite. Thus, vertebrates can be considered segmented animals. The homeo box sequence has not been detected in animals without a segmented body plan. Those examined so far include Escherichia coli, yeast, nematodes, and a sea urchin.

In further work, the Basel scientists have isolated from the frog Xenopus laevis a gene containing a 180-nucleotide region "extremely homologous" to the fly homeo box. They find that this frog gene, like the fly homeotic genes, is active at defined times early in embryological development. The scientists speculate in Cell, "If the frog gene cloned here eventually turns out to have functions similar to those of the fruit fly genes, it would represent the first development-controlling gene identified in vertebrates."

This finding may thus be "a major breakthrough in understanding vertebrate development," says Gary Struhl of Harvard University. Specially, "it means that many of the principles that govern the development of insect segments might have direct counterparts in vertebrate systems."

(Bio-Science, 34, 9(October 1984) p.548)

Probing the Molecular Effects of Dioxin

By Kathy Fackelmann

The mechanism by which cells regulate gene expression may be unlocked by studying dioxin, a trace contaminant of Agent Organge - the notorious chemical defoliant used in Vietnam. Ultimately, such studies may also help explain dioxin's effects on human health.

Since it became known that a dioxincontaining defoliant was widely used in Vietnam, public outcry has spurred investigations into the chemical's toxicity (see December 1983 Bio Science 33; 680-681). So far, research has been unable to provide clear-cut answers. Scientists have shown that dioxin, or TCDD, can cause cancer in laboratory animals, but they still do not know how the chemical affects human health. Acute exposure to dioxin does cause a severe skin rash, chloracne, in humans. Although some researchers suspect that the chemical also causes certain kinds of cancer years after exposure, there are few hard data to back that assertion.

Some researchers believe they will only understand dioxin's toxic effects when they can unravel the chemical's mode of action on a molecular level. Researchers know, for example, that dioxin acts as a chemical switch; it can turn on a cell's enzyme production machinery. But no one understands how dioxin starts this process. One piece of that dioxin puzzle may be provided by recent research at the Stanford University School of Medicine.

"Dioxin is directly affecting transcription of a gene," says David I. Israel, coauthor of a recent report in the Journal of Biological Chemistry (259; 5400-5402). According to data collected by Israel and James P. Whitlock, Jr., dioxin induced a 20-fold increase in the synthesis rate of a certain messenger RNA 30 minutes after it was administered to mouse cells. This cytochrome P-450 mRNA is responsible for producing an enzyme that metabolizes environmental carcinogens.

These results support one theory about how dioxin interacts with a cell's DNA. The Stanford researchers believe that once it enters the cell, dioxin binds to a protein receptor. This dioxin-protein complex then attaches to a specific portion of the DNA, causing it to read the cytochrome P-450 gene more frequently. Thus the cell produces more mRNA and more enzyme.

Cont...34..

There is some speculation that dioxin may be able to damage cells by this mechanism. The P-450 enzyme detoxifies potentially dangerous toxins. But somewhere in the process, chemicals form that are more damaging to cells than the original compound. Some researchers believe these reactive intermediates may induce cancer if the cell cannot eliminate them fast enough.

Determining dioxin's health effects has been made difficult because its toxicity varies with dose and animal species. It takes 5000 times more TCDD to kill guinea pigs, for example, than hamsters.

The new research may help clarify why some animals are more resistant to chemicals such as dioxin. Whitlock explains that certain mice have an abnormal receptor protein that binds with dioxin entering a cell. If dioxin and the receptor hook up in a lock-and-key fashion, the dioxin may not be able to dock properly with a protein receptor having an abnormal attachment site. The mice with abnormal receptor proteins lack the necessary protein-dioxin complex that attaches to the DNA and starts the enzyme production process.

If further research can elucidate exactly how dioxin affects cells, researchers may be able to identify individuals who are less susceptible to dioxin and other potentially dangerous chemicals. Industry, in particular, is interested in such broad future applications. If companies were able to identify individuals sensitive to certain toxins, they could assign them work not requiring handling of those chemicals.

It is by no means certain that dioxin's toxic effects are caused by the proposed mechanism. Daniel Nebert, chief of the NIH laboratory of developmental pharmacology, is unconvinced that dioxin's toxicity could be attributed to the P-450 enzyme. Having more P-450 may not be deterimental to an animal. Because this enzyme is involved in detoxification, more may actually be beneficial. Although some researchers believe that excess P-450 could mean a build-up of toxic intermediate compounds, that has not been proven. Nebert said that dioxin's harmful effects may instead be due to a cell surface disturbance of some sort.

Although practical applications are far in the future, the new research may provide scientists with a biochemical model to explain how dioxin affects the expression of genes, says Howard Eisen, an NIH medical officer studying dioxin. Scientists know that certain chemicals can trigger gene transcription, but the mechanism of that process is not known. By studying dioxin, scientists may be able to understand how the information on a gene is released. "If that were worked out, I think it would have broad implications," says Eisen.

(BioScience, 34, 9(October, 1984) p.543)

The Psychological Dimension in Cancer Treatment

By Steven Greer

(Abstract)

A cardinal principle of medical ethics, primum non nocere, is examined in relation to current cancer treatments. In randomised, clinical trials of such treatments, the quality of life of patients has been largely igonored. The few systematic psychological studies reported so far indicate the likelihood of considerable psychosocial morbidity associated with radical surgery and prolonging combined chemotherapy. Detailed measures of psychosocial adjustment should be included in all future clinical trials of cancer therapy in order: (i) to identify those patients who require psychological help and (ii) to enable clinicians to base their decisions regarding cancer therapy not only on the probability of prolonging or, in some cases, saving life, but also on an accurate knowledge of the quality of that life.

(Soc. Sci. Med. 18, 4 (1984) pp. 345-349)

New Directions in the Understanding and Management of Pain

By C. Richard Chapman

(Abstract)

Control of pain and the suffering that it causes still eludes us. Despite impressive progress in the prevention and cure of disease and in care of the trauma victim, pain is still a frontier in medical research. It accompanies surgery, various diagnostic procedures and dental care as well as acute injury and disease. For a significant number of patients it persists after injury or illness into a chronic state. Chronic pain is recognized to be the most frequent cause of disability in the United States and many industralized nations today, and is a major cost to society in both work hours lost and medical expenses. In addition to its social importance, pain is an intimate cause of personal concern for every human being throughout life. The progress, or lack of progress, achieved by medical research in pain control is of interest to us all.

Pain disorders may be usefully classified in two categories: acute and chronic. The etiology, physiopathology, symptomatology, diagnosis and therapy of these two types of pain are quite different and require separate consideration. Acute pain is that which arises from an acute injury or disease process and persists only as long as the tissue pathology itself. If acute pain problems are not effectively treated, they may progress to chronic states. Chronic pain is that: (1) associated with chronic tissue pathology; or (2) which persists beyond the normal healing period for an acute injury or disease. There are unique challenges for health care providers associated with each of these two categories of problems, and failure to distinguish between these types of pain has led to a widespead, ongoing mismanagement of patients that can be prevented if strong efforts are made to better educate health care professionals about pain and its therapy.

This paper presents an overview of current understanding about the nature of pain and its management. The physiology and psychology of pain are reviewed against a background of the concepts and information taught 25 years ago. Some common acute and chronic pain problems are reviewed and discussed. Finally, several new directions in pain control are described.

(Soc. Science Med., 19, 2(1984) pp.1261-1277)

OOPTHALMOLOGY IN DEVELOPING COUNTRIES

By John Sandford-Smith

In the West ophthalmology is sometimes considered to be a minor specialty, but in developing countries it is one of the most important because the prevalence of blindness in many rural areas ranges from 1 to even 5% compared with about 0.1% in most Western countries. Ophthalmological disorders represent not only a large problem but also a different one; in developed countries the most common cause of blindness is degenerative or vascular disorders of the retina while in the developing countries five major diseases are responsible for most of the blindness - namely, trachoma, xerophthalmia, cataract, onchocerciasis and glaucoma.

Major causes of blindness

Trachoma is common throughout the tropics but especially where there is a combination of unhygienic living conditions, a dry dusty atmosphere, and flies. At least two million people are blinded by this disorder, and it causes discomfort and partial visual loss in about another hundred million. The trachoma organism is spread from eye to eye, usually in young children, by close contact and particularly by flies. Trachoma may be a recurrent disease because one attack confers only a low level of immunity. Recurrent episodes cause increasingly severe conjunctival scarring. Poor hygiene also predisposes towards a high incidence of other types of conjunctivitis, especially adenovirus and bacterial conjunctivitis, which further increase the severity of the conjunctival and corneal scarring. The most effective preventive measure is to promote good hygiene to decrease the fly population and lessen the risk of direct eye to eye spread by contact in young children. Intermittent use of tetracycline eye ointment is also helpful both for treatment and to control the spread of the disease in the community by cutting down the number of active carriers. Tetracycline ointment twice daily for five days each month for six months is the schedule recommended by the World Health Organisation.

Nutritional corneal ulceration is one of the most distressing causes of blindness because it affects primarily young and underprivileged children. In Asia alone it afflicts at least one hundred thousand children each year. The causes are complex - the most important are a dietary deficiency of vitamin A and measles. Vitamin A intake may be increased by nutritional advice, by fortification of foods, or by giving capules of vitamin A every six months. Measles may be prevented by vaccination.

Cataract occurs in all communities but is thought to develop at a younger age in hot countries. About three million people in Africa and five million people in India are blind as a result of cataracts. Of the five major causes of blindness, this is the only one that is treatable. Prevention is at present impossible, but simple eye surgery should restore useful sight.

Cont...38..

Onchocerciasis or river blindness due to the Onchocerca volvulus worm is found in the Savannah region of central Africa, with pockets of infection in central America and Yemen. In many villages its effects are devastating. Blindness usually develops between the ages of 20 and 40. Prevention may be achieved by controlling the insect vector, and the World Health Organisation (working in the Volta river basin in West Africa) is using insecticide spray to control the similium fly larvae, which are found in small fast flowing streams and rivers. It plans to keep this up for about 20 years because that is the estimated life cycle of the worm.

Glaucoma occurs in all communities and is an increasingly important cause of blindness with advancing age. Acute glaucoma is rare in negroes, but they are more susceptible to chronic glaucoma. The only realistic way of detecting early glaucoma that I can think of is to have facilities for eye examination and tonometry available throughout the community. This is obviously a counsel of perfection but whereever appropriately trained primary health care workers or ophthalmic nurses are active in the community they should be able to increase the detection of primary glaucoma in its early stages.

Problems in practising prevention of blindness

Another important feature of ophthalmology in developing countries is the variety of eye disease in different areas. Variations in climate, insect vectors, social surroundings, and nutrition profoundly affect the pattern of dye disease. For example, in Africa on the edge of the Sahara Desert dust, glare, and flies are associated with a high incidence of blindness from trachoma, and corneal conditions such as pterygium and solar keratopathy. Further south in the Savannah dust and flies become less of a problem and the incidence of trachoma falls. This, however, is the zone for onchocerciasis, which is some areas may devastate the entire community. Further south still, in the tropical rain forest, diseases like that due to Loa-loa, which causes acute oedema of the eyelid, and nutritional optic atrophy from cassava are found. Throughout Africa there is a high incidence of measles, corneal ulcers, vernal conjunctivis (chronic allergic conjunctivitis), and leprosy affecting the eye.

To confront this vast and varied problem of eye disease with limited resources and a shortage of skilled staff, not only different technology but a different philosophy of what ophthalmology is all about is needed. Western ophthalmology is mainly concerned with curative treatment, and the equipment used in diagnosis and surgical treatment is complex and expensive. In developing countries prevention is all important and although Western postgraduate training and degress are highly valued such training is not suited to tackling the major blinding diseases in rural communities. Most doctors who have obtained their ophthalmological training in the West go into clinical practice in the big cities and have little contact with the poor rural areas. The people who live there (who make up most of the blind people) are, therefore, poorly served, and for most their only treatment is from unqualified, traditional healers.

Although the World Health Organisation is encouraging cooperation with traditional healers in many branches of medicine, this is not advisable in ophthalmology, for unskilled interference is of limited value and may be disastrous.

What then, is needed to provide an adequate ophthalmic service in the Third World? Not lots of money, not lots of equipment, not even lots of specialists packed like sardines in the middle class areas of the big cities, but a service that is oriented towards the rural areas and prevention. This may be achieved with limited resources and equipment, provided that is is realistically planned and carried out by dedicated workers. There must be good two way contact between the community and the eye specialist. The best way to achieve this is to train primary health care workers or ophthalmic nurses to make the initial contact and then liaise with the ophthalmologist. Village and community leaders may be taught how to prevent blindness from diseases like trachoma, vitamin A deficiency, and measles. Other specialists may be enlisted to help - for example, horticulturists can identify foods rich in vitamin A that may be grown locally. Thus eye specialists must be encouraged to spend some of their time training and supervising medical assistance, nurses, dispensers, and primary health care workers. Obviously most specialists will want a base in a major city, but ophthalmology, with its easily portable equipment, lends itself to mobile work. It is much easier for one ophthalmologist and one trained nurse to travel 200 miles than for a hundred bewildered, blind, and elderly patients with their escorts to travel in the opposite direction.

There are encouraging signs that a more community oriented type of ophthalmic care is being provided in some countries - for example, the mobile eye hospitals, eye camps, and eye safaris in the Indian subscontinent and in some parts of Africa. These are sponsored by the government or by voluntary agencies and offer specialist eye care to the rural communities. The type of service that they usually offer is screening all the local population who complain of problems with their eyes. Those who need medical treatment or glasses are,, whenever possible, given them, and those who need simple surgery - for example, for correction of trachomatous entropion, glaucoma, of removal of cataracts - may have that surgery performed locally. Cataracts may be removed very cheaply by a small surgical team: Usually a nurse prepares the patient and gives a local anaesthetic, cleans the face and eye, and applies sterile drapes. Ideally, the surgical team has more than one operating table and the surgeon can go from table to table doing simple cataract extractions. This entails making a limbal incision in the eye, a broad irdectomy, removal of the lens, and putting in three or four

Cont...40

corneal scleral sutures. In this way a team of two doctors, six to eight nurses, and various unskilled orderlies may get through 100 operations a day. A patient may have his cataract removed (including the price of the drugs and dressings) and be given a pair of spectacles to restore his vision to normal for about US $10.

More complex surgical problems - for example retinal detachments and corneal grafting - are not usually carried out under such circumstances. In some cases the mobile eye clinic provides only a diagnostic service and medical treatment. Patients who need surgery are identified and sent elsewhere.

Equipment

Snellen's chart for testing visual acuity and a pin hole test that distinguishes refractive errors from eye diseases are essential. A black screen for testing visual fields is helpful, but a simple confrontation test using one's own fingers will detect serious field defects.

An ophthalmoscope is essential. Many people do not realise that an ophthalmoscope may also be used to examine the front of the eye as well as the fundus. By holding the instrument as for fundus examination but using a strong positive lens (about + 15 or + 20) a signified and illuminated view of the front of the eye is obtained. If the pupil is dilated slight opacities in the cornea, lens, or vitreous may be seen standing out against the red fundus reflex. A simple torch light and magnifying lens are also helpful for examing the cornea and conjunctiva, and fluorescein paper is essential for detecting corneal ulcers. A tonometer for measuring intraocular pressure is another essential item. The old fashioned Schiotz tonometer is cheap, and if kept scrupulously clean and used correctly it is reliable. Applanation tonometers give more consistent results; the Perkins tonometer and the Glaucotest (made in Germany by Heine) are two useful examples.

A simple microscope to examine skin snips for microflaria is important in areas where onchocerciasis is endemic. More expensive items include a slit lamp and a binocular indirect ophthalmoscope (for example, the Schultz Crock, which has rechargeable batteries, costs £500). These are expensive but provide a superb view of the front and back of the eye respectively and are essential diagnostic tools for the specialist working in a major eye centre.

Cont...41..

Surgery

Nearly all surgery on adults may be done under local anaesthetic. Ophthalmic surgical instruments need to be of good quality and should be packed, handled, and sterilised with great care. Some magnification is necessary for most eye surgery, but an operating microscope is an expensive luxury and perfectly adequate magnification for all but the finest procedures may be achieved using a telescopic pair of operating glasses that will magnify from x2to x4. Of these I recommend those made by Zeiss (East Germany), which cost about £80. Most of the instruments described are robust and, provided the batteries are not left to run down and corrode (and instruments are used for which local batteries and a good supply of bulbs are available), there should be no great problem in operating them. Slit lamps may be run off car batteries with appropriate connections if they are used by mobile eye teams.

Cataract surgery is the most common operation, but other important procedures include the correction of trachomatous entropion and the treatment of glaucoma by iridectomy or a drainage operation. Ideally, only a trained specialist should perform eye surgery of any sort but there is such a shortage of trained ophthalmologists in many developing countries that either a general duties doctor or a nurse with specific ophthalmological training may be taught some of the basic surgical skills. They should then be able to carry out safely the three procedures mentioned above, which encompass up to 90% of the potentially treatable blinding conditions in rural communities.

Drugs

Ba Basic ophthalmology does not require many drugs, and most drops and ointments may be made up by the pharmacist. Tetracycline ointment is the best local treatment for trachoma and chloroamphenicol a good all round antibiotic. Local steroids are effective in the treatment of uveitis and other forms of inflammatory eye disease but may result in serious complications if they are misused. Atropine is the best long acting mydriatic, but a short acting mydriatic - for example, homatropine - should be used to dilate the pupil before examining the fundus. Pilocarpine is needed for patients with glaucoma, to prepare the eye for surgery. Medical treatment of glaucoma is usually inappropriate becuase the patients cannot afford the drugs and are unlikely to comply with long term regular treatment. Many antibiotics and steroid

Cont...42..

preparations may be injected subconjunctivally to treat severe infection or inflammation of the eye. Gentamicin is particularly useful as a broadspectrum injectable antibiotic for bacterial corneal ulcers or endophthalmitis. A supply of placebo drops (zinc sulphate or saline) is useful in some countries where the prevailing opinion is that "a doctor who doesn't prescribe any medicine can't be any good".

Spectacles

In developing countries facilities for manufacturing and fitting spectacles vary widely but spectacles can usually be manufactured locally. Two main types of glasses are needed: spectacles for near vision for elderly presbyopic patients with a power of about +2.5 diopters and aphakic glasses for patients who have had cataracts removed, with a power of about +10 diopters.

In conclusion, the ophthalmic services in common with other medical services in the Third World are often inadequate. The unique challenge of ophthalmology is that most blindness is avoidable without enormous expenditure. The obstacles to prevention are mostly human - unwillingness to work and travel in rural areas, fear of teaching surgical skills to non-specialists and uninterest in community health and preventive medicine - and these must be overcome.

(British Medical Journal 289: 6448
(29 September 1984) pp 811-813)

Drug Treatment of Parkinson's Disease
By J.M.S. Pearce

The new drugs that have become available for treating Parkinson's disease in the past 20 years have given encouraging results, but many problems remain unsolved. Attention to general measures throughout the illness is as important as ever. We need to encourage physical activity, regular walks, and positive attitudes to counter the malignant apathy which threatens independence, both at work and at home. Personal attention and support are probably as effective as formal physiotherapy and speech therapy in most circumstances. Drugs, however, remain the linchpin of treatment.

At the earliest stage, when signs and disability are minimal, the wisest policy is to withold drugs and to observe progress. If rigidity, slowness, and tremor become a nuisance anticholinergic drugs such as benzhexol or orphenadrine may be prescribed; these are generally well tolerated, though occasional troublesome side effects may occur including a dry mouth, urinary hesitancy, and glaucoma. Since they deplete the basal nucleus of Meinert and cholinergic neurones known to be affected in dementia, which may occur later in the illness, many physicians withdraw these drugs as the disease advances.

Anticholinergic drugs eventually fail to modify symptoms, and amantadine 100 mg twice a day is then worth a trial (as an addition or an alternative) before levodopa compounds are introduced. Amantadine has the advantages of a standard dose, few side effects, and conferring benefit within a few days. Unfortunately 30-40% of patients fail to maintain this benefit for more than two months, but in those who do the 20-30% improvement in symptoms and disability scores is worth while.

Usually within two to three years of diagnosis bradykinesia, rigidity, stumbling, and falling cause increasing disability that jeopardises the patient's work. At this juncture dopamine replacement is necessary. Those favouring postponement of levodopa until this stage argue that with time it saturates the brain and forms neurotoxic metabolites (for example, 6-hydroxydopamine) and may contribute to dementia. A former fashion favoured treatment at the time of diagnosis, claiming that replacing the missing neurotransmitter would reverse changes in the postsynpatic neurone responsible for the later fluctuating "on-off" resporses. Experimental and clinical evidence remains equivocal, but most experienced clinicians now start a levodopa decarboxylase inhibitor compound (Sinemet or Madopar) at a stage of threatened rather than established disability.

Cont...44..

More than three out of four patients are restored to near normal activities with this regimen. A lack of response should arouse the suspicion that the patient is not taking the tablets; that pyridoxine (possibly unrecognised in a tonic) or phenothiazines are interacting; or that the diagnosis is incorrect and the patient has striatonigral degeneration, olivopontocerebellar atrophy, Shy-Drager syndrome, or progressive supranuclear palsy.

After six years of levodopa, however, half the patients fail to maintain benefit or cannot tolerate the drug's side effects. Half of the remainder still obtain substantial or moderate benefit, and survival is enhanced to almost normal life expectancy in this group.

The toxic effects of levodopa comprise a succession of motor and psychiatric phenomena - "end of dose wearing off", early morning akinesia, and peak dose dyskinesia. Later, random on-off attacks unrelated to individual doses and painful dystonic cramps of foot or hand may supervene. The most distressing and incapacitating side effects are psychiatric. Depression occurs in half of all patients given levodopa and is best controlled by tricyclic antidepressants. Nightmares and hallucinations are early symptoms of levodopa intolerance; at first these respond to reduction or altered timing of treatment. Daytime agitation and confusion may supervene and merge into a chronic psychosis and ultimately to dementia. Without doubt many of these mental symptoms are due to levodopa acting on an aging brain with concomitant cerebral atrophy in many instances. The contribution of levodopa to dementia is less certain, but since suspicion remains the dose should be kept to the minimum necessary to produce worthwhile improvement of function.

In an attempt to bypass the degenerating nigrostriatal receptor site dopamine agonists were introduced. Bromocriptine, an ergot derivative, stimulates dopamine receptors and has an antiparkinsonian action comparable with levodopa, Its plasma half life is about five hours. The toxic effects are similar to those of levodopa, but psychosis is more severe and may be more protracted despite withdrawal of the drug. When levodopa fails to control symptoms adding bromocriptine may allow a modest reduction of the dose of levodopa and produce an appreciable benefit in some patients. Intolerance, however, is not predictable - nor is it necessarily related to dosage.

Cont...45..

Pergolide is another potent, long acting postsynaptic dopamine agonist. Like bromocriptine it is not effective in patients with primary levodopa failure, but about half the patients with on-off oscillations will derive benefit. Lisuride, a drug with similar potency to bromocriptine, reduces the off phase of on-off swings. The toxicity of these three ergot derivatives is similar, and they remain valuable in extending the useful period of active treatment when the benefits of levodopa are waning or the patient's fluctuating performance is causing problems. The suggestion that low doses of bromocriptine should be given early in the disease in place of levodopa has not yet been substantiated and is not recommended. All of these ergot derivatives should be used with extreme caution in the elderly.

A recent, different approach has become possible with 1-deprenyl, a relatively specific inhibitor of monoamine oxidase-B which is claimed to have a selective stimulant action on the dopaminergic system. A dose of 5-10 mg a day appears to have a weak potentiating action on levodopa. Used alone the antiparkinsonian action of 1-deprenyó is weak but it may be a mild stimulant of the amphetamine type. Its present place appears to be as an adjuvant in selective cases of advancing resistant disease.

At all stages we should aim to confine treatment to no more than two drugs at a time; these should be frequently reviewed with an eye to timing, duration of benefit, and side effects. Hourly charts of symptoms, activity, and side effects recorded by skilled observers throughout the day may allow fine adjustment and lead to new and useful strategies. Even at a late stage it is often surprising how much improvement results from a short period of hospital admission, simplification of treatment, and attention to detail in the domestic arrangements and mental attitudes to the patient's management.

(British Medical Journal, 288, 6433(16 June, 1984)
pp 1777-1778)

A PERSPECTIVE ON NUCLEAR POWER IN THE USA

A study group of the US Atomic Industrial Forum recently completed a year-long study on 'Nuclear power in America's future'. Drawing on the results of this study, AIF President, Carl Walske gives his view of 'what is going on in the US'. This article is taken from a paper given at the recent Uranium Institute Symposium.

The study group consisted of executives from nine utilities, four manufacturers, four architect-engineer-constructors, seven consulting and service companies, and two financial organisations, as well as two lawyers, an organised labour leader and an academian. It was quite an accomplishment fof such a large and diverse group to reach a consensus.

At first the report appears to be the gloomiest ever to come out of the Atomic Industrial Forum but on careful reading it contains plenty of hope for a bright future. The apparent gloom is about present conditions. For example, the executive summary leads off with: 'Nuclear power cannot at this time be considered a viable option on which to base new electric generating capacity in the US. If nuclear power is to complete for new electric generation, ways must be found to reduce the uncertainties and financial risks associated with capital-intensive and long lead-time construction. This is true despite the fact that nuclear power accounted for more than 12 percent of all the electricity consumed in the US last year, despite the fact that nuclear power is expected to account for the addition of more capacity over the next three year than any other means of generation, and despite the fact that nuclear power is being aggressively pursued in other parts of the world.'

But there is also hope for the future in this report. As the executive summary states: 'The study group finds that the problems that have led to nuclear power's extended construction time and high costs are principally institutional rather than technical. They appear to be neither generic nor endemic to the technology underlying nuclear power and should be amenable to resolution by appropriate modification of policies, regulations, procedures and organizations'. There is a will in the industry and in the current government administration to solve our problems with nuclear power.

Cont...47..

Again, from the executive summary: 'The study group concludes that tye nuclear power option will again be available when the public and the public utility commissions realize the option is needed and when it has been demonstrated that the shortcomings that have stalled the option are correctable and are being corrected'.

Appreciation of need

The matter of need, and a general public appreciation of need, for nuclear power is essential. A gross oversimplification of nuclear history in the US starts by making a division at the year 1973. Before 1973, new nuclear generating units were needed on line in America as fast as they could be finished. This produced a pressure on industry and regulators alike to keep projects moving forward efficiently.

After the Arab oil embargo in 1973, energy use fell and electricity use grew less rapidly, so that the US had a surplus of generating capacity. This, in effect, was a vacuum into which all could move. Industry slowed projects because of financial difficulties and lower load growth. Regulators stepped up their requests for changes which also led to longer construction times. And longer construction times mean higher costs.

We can argue that in a time of greater national need for more electricity generation, the American system will again respond efficiently.

Currently there is hope that an obvious 'need' is not far off. After essentially flat electricity growth in 1980, 1981 and 1982, and even in the first half of 1983, electricity consumption in the US was up sharply - by 8.3 per cent - in the year ending 1 July 1984 over the previous 12 months. While such robust growth is hardly expected to continue for long, growth at even four per cent for the next two years would set American utility system planners scrambling. We might even have a few utility executives with sweaty palms, because some for sure would be facing power shortages in the early nineties.

In such circumstances, their options would be limited by the short time until more generation was needed. I suspect that orders for combustion turbines would be the first resort, for service in the early nineties. About the same time, orders for coal-fired and/or nuclear units might be placed, for service in the mid-nineties, depending very much on the climate those technologies then faced.

Cont...48..

A prime purpose of the US Atomic Industrial Forum is to have nuclear power in as competitive and overall as attractive a position as possible by 1986 so that many of those possible orders will be for nuclear power. To that end we have as priorities:

- Maintaining and improving the satisfactory record of operating nuclear plants in the US;

- Completing construction and commencing operation with those nuclear units now being built;

- Overcoming bureaucratic and organizational restraints that are currently barriers to new orders for nuclear plants.

Each of these deserves a little discussion. The operating reactors in the US have a generally satisfactory records. From a cost point of view they produce lower cost electricity than fossil plants built at the same time. However, their capacity factors have averaged in the neighbourhood of only 60 per cent in recent years. Although that figure is generally higher than that of the coal-fired competition, it is not as good as it should be. An average capacity factor of 70 per cent should be achievable in the US, since it is being achieved in some other countries. In fact, in the US there were 12 reactors with capacity factors above 80 per cent in 1983 out of a total of 70 in commercial operation for the full year. Twenty-two were above 70 per cent. Generally we feel that vigorous attention to details, including preventative maintenance and reducing unscheduled scrams, will pay off in higher capacity factors.

The regulatory area is also important for operating nuclear plants. After TMI-2, US regulators raised questions on the need for major plant modifications to deal with the satisfactory cooling of degraded cores. A special industry-funded research project has been underway since the spring of 1982. Some $15 million will have been spent when the project is completed later this year. It appears now that costly modifications do not make sense and, consequently, no operating time should be lost for this cause. Furthermore, the project is expected to make a major contribution to reducing the level currently postulated for radiation releases in major accidents.

Cont...49..

Furthermore, the Institute of Nuclear Power Operations (Inpo) in Atlanta is making steady progress in upgrading nuclear operations in the US. Many utilities outside the US also have an affiliation with Inpo. Inpo's visiting operations evaluation teams, unusual event analysis centre, training accreditation programme and communications network are paying off handsomely. What was once a rather fragmented collection of operating utilities is now more and more an integrated, mutually supportive nuclear power system.

All-in-all, American programmes designed to continue improving the operating performance of nuclear plants seem in good order.

Construction problems

The reactors under construction in the US have been travelling a more difficult course. Due to stretch-outs in their construction times and additional regulatory requirements, their average cost in current dollars will be three or four times that of the operating units. Over a hundred units in the construction pipeline have been cancelled since 1971 but only a few of these had entered the active construction stage. A handful of troubled units have experienced large cost overruns and have even threatened the financial foundation of their utility owners.

Nevertheless, the great majority of the 38 reactors now under active construction in America will be completed in the next three years and begin a life of useful service. Over their lifetimes the electricity they produce will cost about the same as that from their coal-fired contemporaries. Those costs, however, must be reduced for both nuclear and coal-fired generation if electricity in the US is to continue to increase its share of the national energy pie.

Before discussing specific ways of cutting the costs of future nuclear reactors, it would be well to understand better two matters of fundamental importance: the regulatory process and public acceptance of nuclear power.

There are three contributing causes to the rather onerous regulatory scene in the US. First, over the past 15 years America has been engaged in codifying regulatory requirements. In many instances, we in industry were the originators of such codes through standards-setting groups. Too often those groups had inadequate input from field constructors. Tolerances were set by designers who over-specified required tolerances.

Cont...50..

Furthermore, regulators generally pressured these standards groups for tighter specifications. The result has often been to make great difficulties unnecessarily for constructors in the field. Moreover, the heavy stream of new specifications was very difficult to apply without disruption at plants in the middle of construction.

Second there was TMI-2 with its attendant new regulatory requirements. These are generally well known around the world. Their effect, once again, was to disrupt orderly progress on the plants under construction.

Finally, TMI brought an additional regulatory change, somewhat more subtle. While the regulators have always had the last world on safety requirements after TMI the balance of decision-making power shifted strongly from the utilities to the regulators. Disputed proposals for changes are now decided more often the regulators' way. This comes from Congressional and public pressures on the regulators to be 'tougher' following TMI.

There is, however, some cause for hope. The flood of new requirements is abating somewhat. Industry leaders are at work to roll back overly-tight required tolerances. And there is general appreciation that the use of standardized designs could facilitate the approval process for new nuclear plants in the future.

Public acceptance

Public acceptance is always difficult to understand for those of us closest to the nuclear debate. However, a few things stand out from various polling results. Even today somewhat over half the US public favours the continued use of nuclear power. Yet if asked, 'Do you favour building more nuclear power plants?', only a third of those replying answer affirmatively. Just six years ago two-thirds replied affirmatively. Obviously, the question is a bit out-dated, since in the US there has not been an evident need for more electricity generation, of any kind, to be ordered in recent years. Nevertheless, the fall-off in the numbers giving an affirmative reply has been worrisome to those of us in the nuclear establishment.

Cont...51..

Personally, I feel that the US public's changed perspective on America's long-term energy supply situation has a lot to do with decreased support for nuclear power. Just four years ago, when questioned, two-thirds of the American public had energy supply come to mind as one of America's top national problems. Since then we have had no waiting lines at our gasoline stations and, in fact, soft oil prices. Our national administration has reassured the public that our private enterprise system, given a free market, will provide an adequate energy supply. Today for only two per cent of the American public does energy come immediately to mind as a very important national problem. Of course, that two per cent is quite right, but unfortunately 98 per cent of the public is not worrying about energy supply. In such an opinion climate, why should people support nuclear power, a controversial technology with perceived problems?

For a year now the American economy has been growing and along with it energy consumption. If this trend continues, I predict that energy supply will once again be a recognized problem and that along with that realisation support for nuclear power will inevitably increase.

In the meantime, we at AIF, our friends at the Committee for Energy Awareness (USCEA), and our colleagues in many other organisations are at work manning the lines in the battle over nuclear power. We hope to prevent further deterioration in the American public's acceptance of nuclear power, and even to win some improvement. But a major improvement must await a renewed public awareness that an adequate energy supply in America will need a solid contribution from nuclear power.

In the much longer run we shall only win near-complete public acceptance by establishing a good record over many years of acceptable experience in building and operating nuclear reactors. This certainly includes continued safe operation. It also includes keeping nuclear power costs competitive.

Holding and reducing costs

It is not sufficient for nuclear electricity in the US to be cost competitive with coal-fired electricity. New nuclear or coalfired generating plants must also produce electricity at incremental costs which can complete with natural gas and oil in common markets, such as space heating and certain industrial processes. As I see it, that is our fundamental challenge. Long after exaggerated fears of nuclear power have disappeared, we shall still be hard at work holding down and reducing costs. This economic competition will last for several decades, before natural gas and oil supplies in America become too costly to compete head-on with coal and nuclear electricity.

Cont...52..

Fortunately, the US nuclear industry had had enough good experiences to know that it can compete, if it does its best. In the US there is a wealth of nuclear experience. America was early into the nuclear energy field. With a giant economy to fuel, America has built more reactors than any other nation and even its current maimed construction programme is the world's largest. I admit that the United States has probably made more mistakes in the nuclear field than any other country, but with its large programme it may also have more positive experience. Hopefully, the US nuclear industry can benefit from all this experience, good and bad.

Standardised plants

For the future we have learnt in the United States that we can no longer afford to build customised nuclear plants, each individually designed, and each individually examined and approved by the regulators. France has dramatically demonstrated the benefits of standardised plants. These include: substantially completing regulatory design approval for the lead unit, thus greatly simplifying the process for follow-on units; spreading the high cost of design engineering over a number of units; economies associated with procurement of components for several units at a time; stronger and more efficient personnel training programmes, along with greater interchangeability of personnel; immediate relevance to all sister units of construction and operations lessons learnt at any unit; and a broad political support base formed from areas having an economic interest in a particular standard plant.

For the US, turning to standard plants would not mean a single design, but perhaps a handful of active designs to order from at any point in time. As a consequence, competition would still exist between suppliers, with the benefits that industrial competition can bring nevertheless, standardisation would be a new way of life for utilities in the US. Because of the need for its benefits, I believe it must and will come.

AIF report

The AIF study group on 'Nuclear power in America's future', has broken new ground for an industry report by discussing alternative organisational arrangements for building and operating nuclear plants. These would probably be based on the use of standardised plants. I want to quote that report on two alternatives, described there as joint ventures and nuclear generating companies.

Cont...53..

Joint ventures: A group of utilities could join together to finance, construct and operate several nuclear units. Management could be vested in a 'strong' lead utility with successful nuclear experience or drawn from the multiple utility owner/operators. During the design and construction phases of the project, management might be infused from the designer/supplier organisations. The participating utilities would have access to the power produced through take or pay contracts. The practicality of such an arrangement would depend to some extent on the number of state utility commissions and centres of political influence involved. The principal advantages of such an arrangement would be:

- attenuation of the financial risk and the ability to match the percentage of capacity to which each utility commits to its projected demand for electrickpower;

- concentration of the partners' best construction and operations managers on the project;

- increased influence of a group of owners acting in concert to overcome problems;

- the involvement of participating utilities in the project; and

- to facilitate the use of units of standardised design. Potential disadvantages would include:

- loss of independence by the participating utilities and hence a necessity to compromise on design preferences;

- an initial lack of team experience if management were drawn from the multiple owners; and

- the likely involvement and hence necessary approvals of multiple state commissions.

Nuclear generating companies: A corporation could be formed to finance, construct and operate new nuclear units. The corporation could be owned by equipment suppliers, architect-engineer-constructors, utilities or any other investor. The power produced by the nuclear units would be sold to utilities under take-or-pay contracts that could serve as security for the project's debt. The principal advantages of such an arrangement would be:

Cont...54..

- spreading of financial risk;
- concentration of expertise and resources on multiple nuclear units to assure safe and efficient construction and operation;
- retention of economies of scale without overconcentration of a utility's assets; plus
- the possibility of offering innovative financing opportunities.

The epilogue from the study group's report states that: 'Nuclear power, as noted earlier, is a study in contradictions. Never before has a new technology been brought to such widespread and beneficial application in such a short span of time. Never before has a new source of energy been so warmly endorsed and so widely accepted in the same short span of time by such a broad cross-section of people-utility managers, electric power consumers, politicians, industry and labour leaders, etc. And never before has a new energy source come upon the scene at a more crucial time - just as the supply of petroleum upon which the nation had become so dependent was being threatened by an Arab embargo.'

'But this tells only part of the story. Never before has a new energy source received so much attention from the media - not all of it well-informed or balanced. Never before has a new energy source or its underlying technology become so politicised in such a short span of time. And never before has a new energy source been more adversely impacted by circumstances over which it had little or no influence - an unanticipated drop in electric power demand, double digit inflation, and high interest rates.'

'As unprecedented and unfounded as the apprehension of the public and the challenge of the critics may be, the use of nuclear power will not expand to the extent of its technological and economic potential until a consensus in support of such expansion is clearly evident. This will come only by continuing to build on nuclear power's already proven record of safe, reliable and economic electric power generation by and by continuing to make the details of this record known to the American public.'

(Atom 337 (Nov. 1984) pp 7-9)

Bio-Energy-Present Status and Future Perspectives

By Maheshwar Dayal

Popularisation of Family and Community Biogas Plants

High cost of power generation, transmission and distribution especially to rural areas, the immediate need to displace the traditional use of firewood as the major source of domestic fuel to save forest resources, emphasize the need to stress upon biogas plant, to provide not only gas for the homes but also manure for the land, consistent with sanitary conditions. Therefore, the development of biogas alongwith other alternative sources of energy has been included as one of the items under the 20 Point Programme of the Prime Minister. In order to make this innovation an instrument of socio-economic change, an integrated programme combining animal and human waste disposal systems, farming complex and pisciculture needs a critical analysis in the context of the requirements of a 'Modal Village' in terms of both energy conservation and energy generation.

The people who do not have the required number of animals and who do not possess the required open space to build the plants miss the benefit of biogas plants under the normal programme. It is in this context that the concept of community biogas plant is receiving attention in recent years in India as in many parts of the world. The Commission for Additional Sources of Energy initiated the programme of setting up experimental Community Biogas Plants in the country under the All India Coordinated Biogas Project. One of such 12 projects is situated at Masudpur - a village at a distance of 6 KM from Qutab Minar. This project consists of one biogas plant of 85m^3/day capacity for digestion of cattle dung, one biogas plant of similar capacity attached to latrines for generation of biogas from nightsoil (human excreta) coupled with cattle dung and 3 biogas plants of 8m^3/day capacity value, daily gas production from the complex is equivalent to 120 litres of kerosene per day, which in terms of its value comes to Rs.64,800 per year. In addition, 2134 tonnes of enriched manure is obtained annually. The Community Biogas Plant forms one of the elements of an integrated energy systems which is having a noticeable effect on improving the quality of life of the villagers.

Energy from Urban Wasters

Energy from urban wastes can be classified in two categories namely sewage and general municipal wastes, Both of these are causes of significant environmental pollution and need to be treated from the point of view of the health and sanitation of the population. It is now possible by modern efficient methods to extract energy from both these sources while at the same time treating the wastes. Thus the needs of environmental preservation can be met while also extracting energy from renewable biomass resources. For sewage the best

Cont...56...

available technology which should now be applied on a mass scale is generation of biogas as a part of the treatment plants. This biogas can be used to generate electric power which can ensure that the sewage systems (pumps, motors, etc.) work properly. Excess biogas can be used for producing additional electricity for lighting or other purposes or alternatively the additional gas can be used directly as fuel for domestic or industrial purposes. Some projects in this connection have already been installed by the CASE/DNES in different parts of the country including Puri, Padrauna, Patna etc. and they are working very well. It is now proposed to extend this to all major towns. So far as the municipal wastes are concerned two technologies show promise of combining treatment with the energy extraction namely incineration and pyrolysis. A pilot project based on the incineration using about 300 tonnes per day of municipal wastes is being set up in Delhi and an oil plant based on pyrolysis concept is proposed to be set up at Bombay. Such plants also need to be introduced in all our towns and cities.

Improving Efficiency of Traditional Use Patterns

Burning of combustible materials in the open results not only in the dissipation of useful energy but also emission of particulates and gases which result in atmospheric pollution. Development of efficient energy conservation devices such as furnaces, heat exchangers, steam generators, stoves and heaters, can help to provide not only clean fuel with the needs of the house-hold or processing units - small or large. Already a good deal of work has been initiated in the development of such type of energy saving devices at a number of institutes/centres but in the absence of comparative evaluation of the existing designs and lack of standard specifications, not such headway has been made on this aspect. Introduction of suitable modifications in the traditionally used 'Chullah' to improve its combustion efficiency is an important priority action programme in order to provide some 'leisure' to the rural women, consistent with sanitary conditions. With these objectives in view, the Department of Non-Conventional Energy Sources (DNES), has recently initiated a National project on Popularisation of Improved Chulhas in the country. The Project is designed as a programme for women and by women so that they themselves become agent of change for mitigating their drudgery and health hazards by the use of efficient smokeless chulhas. Under the project, which has a multi-nodal and multi-agency approach, several models of improved chulhas both fixed and portable having an efficiency of 10-25 will be demonstrated all over the country. Nearly 1 lakh predominantly women workers will be trained in construction/installation of improved chulhas. It is also envisaged to create nearly 5,000 smokeless villages by integrating the chulha programme with biogas programme.

Cont...57..

Mass Media and Bio-Energy

The importance of a well organised information and documentation system as an aid to scientific and technological advancement of a country needs no emphasis. This is particularly true for a newly developing field like Energy from Biomass. In order to provide a holostic approach to energy planning and management, the interaction of policy makers, administrators and the rural people is highly essential. Mass Media, in its variety of manifestations like Akashvani, Doordarshan, Press Information Bureau, Directorate of Advertising and Visual Publicity and Publications Division, Newspapers Journals and News Agencies, offers a potential instrument for bringing about cultural, social, scientific and technological revolutions in the country; but development of a proper input system based on accurate factual information is a pre-requisite to derive maximum benefits.

The establishment of a Communication Cell having a computerised data bank deserves top priority in order to cater to the vast network of communication agencies already existing in the country. Preparation of a directory of organisations; collection, compilation and integration of information, material-wise, technology-wise and area-wise constitute vital activities which act as catalysts to accelerate the pace of progress in science and technology, particularly in newly developing areas. Maximum interaction of all categories of this 'Biogas Community' through various forums is a pre-requisite to bring about a change in our thinking, philosophies, attitudes, and working patterns in order to achieve our cherished goals. Mass Media, with its forceful voice and impact offers a promising scope to usher in this transition - it all depends upon how well it is made use of in this challenging field.

Bio-Energy Programme vis-a-vis Agriculture and Forestry Practices

Some people equate biomass energy systems with agriculture and forestry practices, but a critical analysis reveals many differences as regards nature of the problem, options and scope. Biomass has a much wide variety, of availability and much wider options and scope. Depending upon the quantity and quality of substrates a wide spectrum of technologies can be used for conversion into portable, storeable and readily available forms. However, the biomass conversion processes should take into account the seasonal supply position, the feasibility of the technology and market competition. Only a true understanding of an inter-disciplinary knowledge of photosynthetic productivity, ecology biotechnology, global energy systems and social issues will help establish a national biomass energy policy in relation to other forms of energy for the country.

From this survey, it is evident that biomass offers a potential scope to provide a renewable source of energy consistent with minimum environmental problems but this is an area where for production of

Cont...58..

appropriate biomass, scientific methods of the type that have made modern agriculture possible will need to be employed ; and for its optimum utilisation, the most powerful and modern methods of chemical engineering and bio-technology, are called for.

In conclusion, it may be stated that a beginning has been made, but keeping in view the magnitude of the problem and complexities of the various facets, there is a need to develop a management approach based on a critical analysis of the various factors. Biomass programme is a task of such huge proportions that India's industrial, agricultural and educational capacity will have to be fully involved. It would require an inter-disciplinary approach with scientists, foresters, engineers, agriculturists and professionals drawn from specialised fields. Greater and more emphasis on proper manpower planning to handle this newly emerging area of research and development is also crucial with attention to the multiplicity of all these factors, fuller and increased uses of bio-energy can be developed for India's progress.

(World Science News)

Pesticide Policies Change Slowly

By Judith S. Weis

Since the 1962 publication of Rachel Carson's Silent Spring, pesticides have been an issue of public concern. Chemical pesticide use has increased tenfold over the past two decades, yet about one-third of US crops are still lost to pests. Our mechanized and highly productive agricultural system depends on pesticides, but because they are designed to kill, they are, by their very nature, unsafe. Although concern over environmental and human health effects wanted after DDT and other chlorinated hydrocarbons were banned in the early 1970s, the public has recently begun worrying about the dangers of other pesticides.

Under 1972 amendments to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), EPA must approve new pesticides before they go on the market, as well as review and reregister pesticides used before the law was passed. To ban an old pesticide, citizens or organizations opposing its use must present substantial evidence that its risks outweigh its benefits.

When Anne Burford was EPA administrator, many unregistered pesticides were used under "emergency exemptions" and "special local needs" registrations. The toxic effects, especially long-term ones, of many commonly used products remained unknown.

As reported recently by NAS, approximately 80% of some 600 generic pesticides in use have not been adequately studied for their risk in producing cancer, genetic changes, or birth defects. Furthermore, some test results, particularly from one laboratory, had to be discarded because of fraudulent data (June 1984 BioScience 34: 399). At the same time this study was released, EPA scientists were under pressure to rubber-stamp approvals of new chemicals quickly without adequate data analysis.

Hearings in November 1983 before Congressman George Brown's (D-CA) Subcommittee on Department Operations, Research & Foreign Agriculture focused on these and other problems within EPA. Although Congressman Tom Hakim (D-IA) and Senator William Proxmire (D-WI) introduced FIFRA reform bills, the bills have not made progress because they must go through agriculture committees, which seem lukewarm on tightening loopholes in this law.

...

Cont...60..

Other well-publicized events, however, have drawn new public attention to pesticides. Last year health officials found ethylene dibromide (EDB), a potent carcinogen, in wells supplying drinking water in Florida and other areas with sandy soil. Because this substance was once thought to evaporate and leave no residues, it had been exampted from tolerances (limits on residues) on foods. After a public protest over high EDB residues in foods and regulatory actions taken by some states, however, EPA finally decided to curtail EDB use for disinfecting or destroying pests in soil, grain, and citrus fruit. Yet hearings before Senator David Durenberger's (RMN) Subcommittee on Toxic Substances and Environmental Oversight in January 1984 revealed that EPA's Office of Pesticides and Toxic Substances was not enforcing these controls - even after the agency found that significant residues remained on treated food.

To prevent similar future health threats, Congressman Henry Waxman (D-CA), chairman of the House Health and Environment Subcommittee, introduced a bill allowing EPA to revoke a suspect pesticide's exemption from tolerance requirements and to establish tolerance at a safe level or reduce a previously established tolerance. In setting a tolerance, the risks of cancer or other chronic health problems associated with a chemical must be considered. In addition, EPA will be required to review and evaluate data on old pesticides.

On another front, researchers are developing biological control agents, such as insect hormones and pheromones, much more specific in their targets and effects than are broad spectrum chemicals. Integrated pest management (IPM) programs can be environmentally safe ways to reduce the use of toxic chemicals and resulting risks. Transferring IPM research into commercial products, however, is slow and has not been well supported by USDA. But organic farming, including IMP, is provided for in the proposed Agricultural Productivity Act (S 1128). The bill's sponsor, Senator Patrick Leahy (D-VT), held hearings on this bill before the Senate Agriculture Committee. Similar legislation (HR 2714) introduced by Congressman James Weaver (D-OR) has already passed in the House.

Cont...61..

In addition, the House Environment, Energy, and Natural Resources Subcommittee, chaired by Congressman Michael Synar (D-OK), held overview hearings on EPA's pesticide activities. Committee members focused on the conditional approval given to "Larvadex" (Cyromazine), a pesticide fed to chickens to prevent fly larva growth in their feces. Residues of this pesticide remain in both chicken meat and eggs. Because scientists suspect a metabolite of cyromazine (melamine) causes bladder tumors, the pesticide's approval is controversial. EPA Associate Administrator for Pesticides and Toxic Substances John Moore testified at June 1984 hearings that high concentrations of melamine led to production of bladder stones, which, in turn, caused tumors. According to Moore, low doses of the chemical are unlikely to cause problems. The committee also reviewed EPA's failure to curtail use of another pesticide, Dicophol, which listed DDT as an "inert ingredient."

Pesticide legislation has also been tied to issues surrounding the potential environmental impact of releasing genetically engineered organisms (December 1983 BioScience 33: 681-682). During the 98th Congress, legislators held hearings on environmental release bills and proposed amending laws in an attempt to come to grips with this issue. However, such legislation-as well as most other bills cited in this article - could not be fully considered during this short, election-year congressional session, and scientists are now looking toward the 99th Congress for landmark legislation concerning pesticides.

(BioScience, 34, 9 (October 1984) p. 549)

PROBLEMS AND POLICIES ASSOCIATED WITH ACID RAIN

By

Byrom Lees

Introduction

Acid rain and the problem of acidity of rivers and lakes in Scandinavian countries, particularly Norway, has been known for many decades. Indeed, in Norway it has been the practice for many years to introduce limestone or chalk pebbles into rivers to help to increase the alkalinity of rivers and lakes. Local communities have appreciated that the low pH of rivers flowing from regions where granite and similar geological formations predominate requires the addition of calcium hydroxide and other basic minerals.

Attention was drawn to the problem of acid rain at the 1972 UN Conference in Stockholm on the Human Environment and there have been many reports in the press on the subject. Since that Conference there has been evidence of deterioration of trees in Central Germany, said to be due to acid rain, and coverage of the subject has become even more intensive. Much of this has been very dramatic and exaggerated, especially since Prof. Ulrich put forward his hypothesis that acid deposition from the atmosphere acting on light, sandy, naturally acid soils would alter the balance of aluminium to calcium in the soil to the detriment of fine tree roots. An example of such reporting is that from the Sunday Times: 'A gentle blitzkrieg whose steady patter spells death to forests'; or Anthony Tucker in the Guardian: 'Britain's unwanted gift of acid rain hits trees'.

There is a similar atmospheric pollution problem in Canada and USA which has also been associated with the acidification of lakes and damage to trees.

Many reports blame the main industrial source of sulphur dioxide emission as being the cause of the problem. Such sources are industrial areas in Europe, the U.K. and the central industrial belt in USA. Power stations, in particular, have been singled out as large emitters of sulphur dioxide.

The problem has been considered very seriously in the UK and several major meetings have been held in the past few months, notably at the Royal Society of Arts, the Royal Society, the National Society for Clean Air Annual Conference and the Watt Committee. Recently Warren Spring Laboratory has completed a survey on

Cont. /2

'Acid deposition in the United Kingdom' for the Department of the Environment and a lecture has been given on 'The Implications of Acid Rain' at the Parliamentary Liaison Group for Alternative Energy Strategies. The meetings have considered the problem both in scientific and economic terms. The conclusions of the various meetings are not widely different and it is proposed to summarize them in this report.

Acidity of rain due to the combustion of fossil fuels

The main subject under consideration is acidification of rain, that is wet deposition associated with the combustion of fossil fuels - coal, oil and natural gas. Dry deposition of gas-borne products also causes widespread acidification. The three constituents of the flue gases which mainly affect the acidity of rain are carbon dioxide, oxides of sulphur and oxides of nitrogen.

The acidity, or slkalinity, of water is expressed as its pH. A sample of rain water is analysed with an instrument which measures the concentration of H^+ ions in units of pH. The pH scale, which is inversely related to H^+ concentration, runs from zero to 14 where a pH value of 7 is neutral. The pH values going from 7 to zero have an increasingly higher concentration of H^+ ions and acidity, while values going from 7 to 14 have lower concentrations of H^+ ions, less acidity and increased alkalinity. Because the pH scale is logarithmic, a decrease of 1 pH unit (ie 7 to 6) corresponds to an increase of H^+ concentration by a factor of 10.

Carbon dioxide in the atmosphere causes rain to be acidic but only to a very limited extent. The pH of rain due to CO_2 will be about 5.6. If all oxides of sulphur and oxides of nitrogen due to combustion of fossil fuels were eliminated, the pH would be 4.7 to 4.9 due to natrual emissions of oxides of sulphur and oxides of nitrogen. In areas where acid rain is occurring, the pH of rain can be as low as 3.5 with an average of about 4.3. Soda water is about 3.5.

The main man-made source of oxides of sulphur is the combustion of coal and heavy fuel oil in power stations and industrial plant whereas the source of oxides of nitrogen is divided between stationary sources and transportation sources as shown in Table I obtained from American data.

Cont...64..

Table 1 : Sources of man-made pollutants in America

Source category	SO_2%	NO_2%
Transportation		
Highway vehicles	1.6	29.7
Aircraft	-	0.4
Railroads	0.4	3.1
Vessels	0.9	0.9
Off-highway	0.4	6.6
Sub-total	3.3%	40.7%
Stationary		
Electric utilities	65.3	32.2
Industrial	9.4	18.1
Institutional	4.1	1.8
Residential	1.2	1.3
Sub-total	80.0%	54.4%
Industrial processes	16.7%	3.5%

Oxides of sulphur

Considering sulphur dioxide production in Europe, including USSR, the overall current total is about 60 million tonnes pa as SO_2 of which some 4.25 M t is produced within the UK. In the UK the production of SO_2 has been reduced by nearly 30% since 1970 as a result of the industrial recession and fuel economy, the greater use of natural gas and the generation of a higher proportion of our electricity supply by atomic energy. SO_2 emissions in the UK are now no higher than in 1940.

It is often stated that the sulphate content and acidity of rain over Europe increased sharply with the growth of SO_2 emission from oil-fired plant in the 1960s. This was not borne out by measurements made in Sweden. In the period 1965-1975, during which the SO_2 emissions in Europe increased some 35%, the measured sulphate deposition decreased in Sweden.

Remarkably, acidity of rain is frequently no higher near to the areas where the greatest emissions of SO_2 occur - such as in the neighbourhood of power stations and in industrial areas in the Midlands in the country. This may be because the SO_2 in the atmosphere must first be converted by photochemical oxidation to So_3 before it causes acid rain. This has been postulated recently in several papers in America and the UK. So_2

Cont...65..

is oxidized to SO_3 at 3 to 4% per hour in mid-day conditions but only at an average of 1% per hour over 24 hours. The sulphur trioxide reacts rapidly with moisture to form sulphuric mist or aerosol. This acid may be removed by wet precipitation (acid rain) or by particulate dry deposition.

It must be remembered that emissions from the UK must travel at least 1000 km to Scandinavia and the travelling time will be 1 to 2 days, most of the time over the sea. Only a very small percentage of the oxides of sulphur produced in this country will reach Scandinavia.

Modern methods of combuston are used to ensure minimal production of SO_3 in power stations with oil-fired plant. In addition magnesium hydroxide is added to the flue gases to neutralize any remaining SO_3, thus ensuring that localized acidic deposition is avoided.

Likewise modern coal-fired plant in power stations burns coal as pulverized fuel and most of the sulphur is emitted as SO_2. Below 1% of the SO_2 is converted to SO_3. With modern coal-fired plant the ash in the coal is carried as a fine powder which is collected in the electro static precipitators. The ash is in the form of small flassy spheres, cenospheres, which have no neutralizing properties and, therefore, some modern coal-fired plants also add magnesium hydroxide to the flue gases to avoid local acidic deposition.

In contrast, older coal-fired plant used to emit flue gases with a higher concentration of SO_3 due to their method of combustion together with smoke and fly-ash. The emitted solid particulates contained neutralizing agents and absorbents. The old industrial plant and power stations caused for greater pollution locally in the UK. Also, of course, until 25 years ago, we had serious smog problems due to inefficient combustion of coal in domestic open fires and small industrial plant with resultant ill-health, deaths and disruption of life.

Did the emission of these other impurities reduce the effect of photochemical oxidants and hence reduce the oxidation of SO_2 to SO_3 in long distance travel? Did these other impurities absorb or enutralize acid constituents? Does this mean that control of photochemical oxidants would reduce acid rain whereas reduction of SO_2 will have negligible effect? There are insufficient data to answer these questions.

Oxides of nitrogen

Oxides of nitrogen are produced from combustion of

Cont...66..

fuels in industrial plant and the concentration may be as high as 1000 ppm in the flue gases. Oxides of nitrogen are also produced in the exhausts of motor vehicles and may be at a concentration as high as 2000 pppm. The latter is emitted locally and is probably the controlling factor of nitric acid pollution in towns and cities. Overall the controlling factor is provided by both forms of production. Suitable catalytic converters can remove most of the oxides of nitrogen produced in car exhausts.

Since 1945, the emission of SO_2 in the UK has not varied greatly and has peaked at about 2.5 M t of sulphur pa but the emissions in Europe have doubled over this period from 10 M to of sulphur pa to 20 M t of sulphur pa. On the other hand in the UK the emission of oxides of nitrogen has shown a large increase from 0.3 M t of nitrogen pa to 0.6 M t of nitrogen pa. This is due to two factors, the combustion of oil and coal in very large boiler plant, where conversion to oxides of nitrogen is higher, and an increase in the emission of oxides of nitrogen due to the increase in the car population.

Acidification of lakes

Considering Europe alone, the most serious problems associated with acidification of lakes have been reported from Southern Norway and Sweden. The 1972 Swedish case study suggested that sulphate levels in Scandinavian waters were rising at a rapid rate with a corresponding alarming increase in acidity - 23% pa from 1965 to 1970 in the case of Lake Vanern and 8 to 12% pa in four other large rivers and lakes cited. This suggestion was not repeated in the 1982 study nor were more up-to-date data given. From such data as have been published for the 10 year period from 1965, it is not possible to discern any significant trend in pH in these waters. Monitor, the year book of the Swedish environmental authorities, states 'In conclusion, an acidification in the strict meaning of the word (ie increased acidity) has generally not occurred in large rivers in Sweden)'.

The problem arises in small lakes and streams, large numbers of which have pH values below 5.

Over the great majority of Europe, acid deposition is completely neutralized by calcium and other basic minerals in soil on its way to streams and rivers, the increased level of sulphate in surface water being matched by a corresponding increase in these basic elements. It has been observed that acidification can occur due to humic acid from forests being washed into lakes in those areas

Cont...67..

where alkaline neutralizing agents are not present in adequate quantities. In Britain, there is some evidence that some small lakes are becoming slightly acidic, but further data are required.

Deterioration of forests

Deterioration of forests has been reported from Central Europe, particularly West Germany, where there is said to be observable damage to spruce and fir trees. The damage is in high elevation forests, over 600, 800 or even 1000m above sea level.

Various suggestions as to the cause, in addition to acid rain, have been put forward. These include the severe drought in 1976, ozone attack and direct attack by the pollutants SO_2 and oxides of nitrogen. A reduction in SO_2 emission on their own may well be insufficient to stop the decline of these forests if ozone is one of the primary causes.

Ulrich has put forward a theory associating the forest deterioration with the liberation of aluminium ions due to the loss of calcium and magnesium. This is controversial.

Local husbandry in Germany has been questioned by some British biologists.

In Britain, there is little evidence of damage to forests either from pollution or acid rain, other than from known point sources of intense pollution. It is very doubtful whether emission of SO_2 from the UK and Ireland affects pollution problems in Central Germany to any appreciable extent.

Methods for reducing the effects of acid rain Desulphurization

Various methods of desulphurization have been suggested. The simplest and lowest cost is to wash the flue gases with a chalk slurry and to dispose the calcium sulphate produced in a local river. Battersea and Bankside Power Stations used this process, disposing of the effluent in the river Thames, over a period of some 40 years. By modern standards these stations were comparatively small and this technique could not be applied to present-day stations. In systems now being considered, either the extracted products, generally calcium sulphate, are disposed of as a solid or, in more complicated and expensive extraction systems, the sulphur is recovered.

Cont...68..

The introduction of fluidized bed combustion would also enable SO_2 to be extracted from the flue gases. So far, even in small plant, the adoption of FBC is proceeding very slowly and no large prototype plants are operating yet.

It has been estimated that, for a 30% reduction in emission of sulphur oxides from power stations alone in the UK, it would cost well over £1 billion capital and would lead to a total annual cost of about £250 M, corresponding to an increase of 4 to 5% in the price of electricity. There would be other environmental costs arising from the need to quarry and transport very large quantities of limestone required in the desulphurization process and to dispose of the resultant waste. There would have to be a uniform policy throughout Europe including Russia and the Eastern Bloc.

Even if this reduction of SO_2 was achieved and no other measures were adopted, there would be no appreciable benefit relating to the problem of lake acidification and tree defoliation in the short term. The long term benefits are unknown.

Reduction of sulphur emission could, in addition, produce other benefits such as reduction in damage to buildings and improvement in agricultural yields.

Neutralization of acidic pollutants

Sweden has contained its fishery problems by liming its lakes. This was said to be at a cost of £2.5 M pa in 1972. In principle, only 10g of limestone is needed per m^2 of catchment area each year to counter the heaviest deposition in Scandinavia. With improved understanding of the causes of fishery decline, better techniques can no doubt be devised. A European fund for such measures would involve less than 1% of the cost of the programme of SO_2 controls being considered by the Community.

Norway has known for generations of the need to add alkalis to rivers running from granite mountainous areas in order to maintain fish stocks. It is understood that rivers and streams that would otherwise be acidic are treated with limestone pebbles or rocks on a regular basis.

Consideration should be given to the suggestion that extremely fine alkaline powders, such as magnesium hydroxide, should be introduced into the flue gases from power generating plant in the ducting before the

Cont...69..

chimney. The quantity added would be less than 0.1% of the fuel consumed. The fine powder would be carried as a gas and would only be precipitated when a rain zone, such as Scandinavia, was reached. It would help to neutralize both oxides of sulphur and oxides of nitrogen. The process reduces acid attack in power station chimneys and the cost would be of the order of 1% of the cost of desulphurization.

Reducing emission of hydrocarbons and oxides of nitrogen from road vehicles

Pollution due to photochemical oxidants and to oxides of nitrogen would be reduced by removing lead from petrol and by fitting suitable 'Three Way' and 'Oxidation' catalysts in the exhaust systems to remove carbon monoxide, hydrocarbons and oxides of nitrogen.

This would have the effect of increasing fuel consumption by some 10%, increasing the price of a car by some £300 and restricting the speed of cars to avoid damage to the exhaust system.

Oxides of nitrogen in the atmosphere have increased by 100% since 1945 so that reduction by the use of catalytic converters could be beneficial. Further, some scientists believe that the reduction in photochemical oxidants would reduce SO_3 formation and rain acidity.

Recently in the House of Commons, Mr. Curry, Governor of the State of Massachusetts and his colleagues stated that there had been a reduction of smog incidents in Los Angeles by some 55 pa since the introduction of leadless fuel and catalytic converters and that there had been a 60 to 70% reduction in ozone in certain regions.

Conclusions and recommendations

1. Whilst it is agreed that the emission of SO_2 from the UK is amongst the highest in Europe, if not the highest, it must be remembered that:

   (a) There are other high emitters, notably West Germany and East Germany whose combined emissions are nearly twice as much as the UK. other high emitters are Czechoslovakia and France.

   (b) Emissions from the UK travel considerable distances over the sea before they reach Europe, eg 1000 km to Scandanavia.

Cont...70..

2. The most emotive issues at the present time are damage to aqua eco-systems and to forests but probably the most important, monetarily, is damage to agriculture and buildings.

3. Emission of oxides of sulphur and oxides of nitrogen in flue gases can be reduced by:

   (a) Extension of the use of renewable sources for heat and power generation. This is likely to be a very long term.

   (b) Fuel economies. This is having and will continue to have some effect. Further fuel economy programmes should be put into effect as quickly and vigorously as possible. The introduction of combined heat and power and combined gasification and power generation systems could save fuel and reduce pollution but the developments will be long term.

   (c) The Severn Barrage scheme. This could produce 10% of the nation's electricity supply with a corresponding reduction in atmospheric pollution. The programme to evaluate and introduce the Barrage should be given priority.

   (d) Optimum operation of existing atomic power stations. New atomic power stations would reduce correspondingly the emission of flue gases containing carbon dioxide, oxides of nitrogen and oxides of sulphur.

4. Introduction of local measures to counter the effect of acid precipitation should be encouraged. We should demonstrate in the UK how introduction of limestone into known acidic streams feeding acid affected lakes will enable fish populations to be restored. This should be carried out with scientific control to demonstrate the recovery of the lakes. Similar measures should be introduced into affected areas in Europe with EEC support.

5. Introduction of extremely fine alkaline powders such as magnesium hydroxide, into the flue gases from both oil-and coal-fired power stations to assess their effect on affected areas should be the subject of a scientific investigation. The transport of the powders could be followed by the use of radio-active isotopes.

Cont...71..

6. The introduction of desulphurization to coal-fired power stations should only be adopted after the cost and likely benefits have been evaluated by European bodies which must include representatives from Russia and the Eastern Bloc as well as Western democracies. The benefits to the UK are likely to be far less than to other countries because we are an island. Clean air blows in from the north, west and south-west. The results of the Royal Society long term survey is awaited with interest.

7. The introduction of lead-free fuel and catalytic converters in passenger cars should only be considered after the cost and likely benefits have been evaluated by the EEC. The benefits to the UK are likely to be less than to other countries because of our position and temperate climate.

8. It is vitally important as recommended in Acid Deposition in the UK (Warren Spring Laboratories, December 1983), that more comprehensive data are obtained from many more points in Britain to establish:

   (a) Atmospheric pollution characteristics, particularly relating to acidity of rain, ozone and photochemical oxidants;

   (b) pH and other characteristics of water in rivers and lakes, particularly relating to the effect of introducing limestone, chalk or other alkaline rocks.

   Financial support of scientific surveys of this type should be made available immediately.

(Energy world, No. 117 (August/September 1984) pp 2-5)

BIOTECHNOLOGY FOR DEVELOPMENT: PROMISE AND PROBLEMS

By Elmer L. Gaden, Jr.

Biotechnology is very much in vogue these days, not only in the industrialized, "high-tech" world but also for developing countries. In 1982 a BOSTID Workshop (see Priorities in Biotechnology Research for international Development: Proceedings of a Workshop, National Academy Press, Washington, D.C. 1982) addressed the prospects for biotechnology in international development in these terms:

"Recent research in cell biology, molecular genetics recombinant DNA, and related fields appears to be laying the groundwork for important technological developments.

"The resulting technologies are likely to have a major impact on a variety of economic activities involving food, chemistry, pharmaceuticals and energy and environment. There are also likely to be significant industrial applications through new products and processes. Through direct participation, or through the impact of work done elsewhere, developing countries will feel the effect of these new developments in science and technology over the coming years".

The recent (August 1984) Third Conference on Chemical Research Applied to World Needs (CHEMRAWN III) in the Hague also featured "biotechnology" prominently, especially "(Bio)chemical Process Bridges to Meet Future Needs".

The roots of this current fascination with biotechnology can be found in the steady growth in our understanding of the mechanisms by which genetic information is stored, utilized, transferred, and transformed. In less than four decades we have moved from ignorance of the chemical nature of the genetic material in cells to the easy ability to order various components of the genetic apparatus from catalogs!

These breathtaking advances in molecular biology owe much to a number of vital developments in laboratory techniques for deliberately manipulating and modifying genetic material. One of the most important of these in terms of technology is embodied in the 1980 patent granted to biologists Stanley Cohen (Stanford University) and Herbert Boyer (University of California), which described a method for splicing and recombining DNA strands to create new genes. This procedure has already been successfully exploited on a commercial scale: e.g., in the production of human insulin by bacterial cells.

Cont...73..

The deliberate alteration of genetic characteristics is, of course, not new. Hybrid corn, high-yield rubber trees, and the army mule are familiar examples of the breeder's art. But the methods available were, until recently, slow, imprecise, and largely limited to a single species. The new techniques offer opportunities not only for rapid and specific changes but also for the transfer of characteristics between species, as in the production of insulin noted earlier.

All these developments have led to a worldwide burst of enthusiasm for biotechnology, with the more ardent protagonists predicting a new "industrial revolution". In the developed nations this enthusiasm has found expression in:

-Large commitments of research support, both by government agencies and by established private companies especially those in the health care, chemical and food production sectors.

-Rapid evolution of a new breed of private, risk capital ventures, primatily in the United States- the socalled biotechnology companies.

-Major alterations in the patterns of university research in the life sciences.

-An explosion of publications, ranging forms new (or retitled) research journals to a rash of newsletters and magazines devoted to the business aspects of the new biotechnology.

To counsel caution and restraint in such an optimistic atmosphere is not a populat role, but the opportunities that the "new biology" offers are accompanied by potential pitfalls. On the one hand, we may be raising expectations that will fall far short of fulfillment; on the other, we can, in single-minded exploitation of a particular set of techniques, overlook areas of immense economic and social potential. It is this latter prospect that is of special import for developing countries. Indeed, in this climate of enthusiasm it is easy to lose sight of the fact that biotechnology, actually, is not new. With the possible exception of extractive metallurgy, it must certainly be the oldest organized human technological effort.

At this point, it is wise to define what we mean by "biotechnology". Are we talking about the extensive e exploitation of living systems so prominent in the

Cont...74..

technological activities of all civilizations past and present, or are we restricting our concerns to opportunities based on the deliberate manipulation of genetic materials? There is no question that these new techniques offer exceptional promise for the manufacture of "high value added" ("high tech") products, but it is the broader-and traditional interpretation that holds real promise for developing nations.

To support this view, one need only quote the official definitions of biotechnology that have been put forward by the various government and international commissions established over the last few years to examine the prospects for biotechnology. Since they are all virtually identical, I shall note only a few:

-"Biotechnology consists of the application of scientific and engineering principles to the processing of materials by biological agents to provide goods and services". (Organization for Economic Cooperation and development).

-"(Biotechnology is)the application of biological organisms, systems, or processes to manufacturing or service industries". (United Kingdom).

"(Biotechnology is) the utilization of a biological process, be it via microbial, plant, or animal cells, or their constituents, to provide goods and service". (Canada)

(These definitions are taken from the comprehensive 1984 report by the office of Technology Assessment of the Congress of the United States entitled, Commercial Biotechnology An International Analysis).

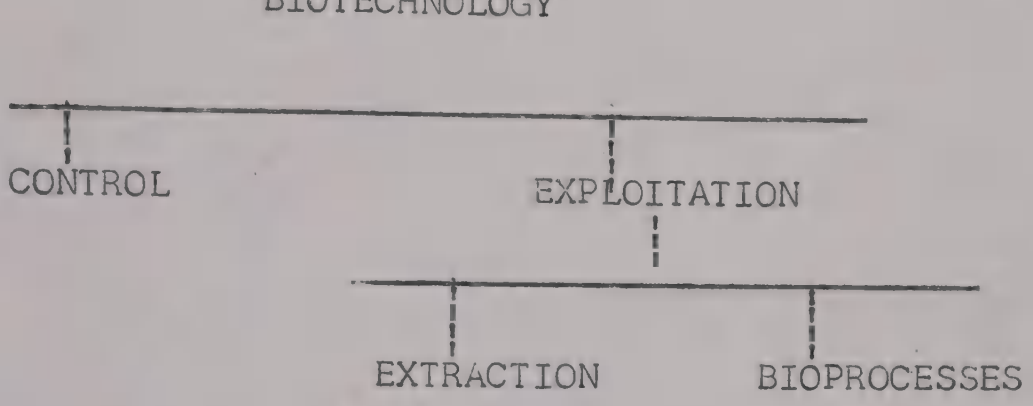
I prefer a definition of biotechnology which reflects my firm belief in a comprehensive interpretation of this area of human activity:

"Biotechnology comprises all aspects of the technological exploitation and control of living systems."

This approach makes no distinction between technologies that utilize biological agents or processes as such-the emphasis in all the formal definitions noted earlier-and those that exploit the products of living systems such as wood, natural oils, and other products of plant or animal metabolism. Furthermore, biotechnology is not limited to changes brought about by living cells or their components. The thermal conversion of a biological raw material, pyrolysis or gastification of wood, for example, constitutes "biotechnology" according to this viewpoint.

Cont...75..

A Schematic representation of this broad interpretation of biotechnology would look like this:



"Control" deals with methods for eliminating biological populations or limiting their growth and the extent of chemical or physical changes that may result from their presence. Control includes methods for food preservation not only of consumable products but also of basic commodities in storage (see Postharvest Food Losses in Developing Countries. National Academy of Sciences, Washington, D.C. 1978). Another aspect is the prevention of material degradation. The widespread use of conventional chemical- and possibly, biologically produced-agents for the preservation of wood is a case in point. Below ground use of wood (for example, for foundations) is now possible in warmer climates where only recently such applications were impossible. Indeed, the need for more effective means for the nonmedical control of biological populations and their effects may constitute the most significant challenge for biotechnology in the developing world. Regrettably, it does not appear to be receiving much attention.

The other face of biotechnology utilizes the prolific and often unique abilities of living cells and issues to catalyze chemical change and to synthesize complex molecules. There are two approaches to the exploitation of the chemical abilities of biological systems. We can go to nature and recover for our use substances that are produced naturally. Familiar examples are cane and beet sugar, oils and fats, dyes, and pharmacologically active materials. Mankind has always relied on plant and, to a lesser degree, animal sources for such substances. I have termed this "extractive" biotechnology.

In some cases only the most rudimentary techniques are required to recover desired materials from their natural sources. To obtain sugar, we need only crush and compress cane or leach beet with warm water. In other instances

Cont...76..

it is necessary to employ more violent means for disrupting the natural structure to recover the substances we want. These result in substantial modification of the source material and, frequently, of the target product itself The disruption of wood to obtain cellulose fibers, which can then be reconstituted to form paper, is an example. To separate and recover the fibers, other potentially valuable substances like lignin are degraded to a point where they can be used only as fuel.

As we view the full spectrum of extractive biotechnology, we cannot fail to note that these activities are among the oldest practiced by man. Moreover, the methods used have changed little in principle over the millenia. A comparison of modern technology with that employed in early Egypt reveals only the substitution of steel for stone and wood equipment and motors, pumps, and automatic controls for slaves.

A second approach to the technological exploitation of the potential of living systems is through "bioprocesses". Here we employ complete living systems (cells or tissues)-their components (enzymes, chloroplasts, etc.)-in a directed and controlled manner to bring about desired physical or chemical changes. The phrase "directed and controlled manner" is critical to the bioprocess concept. Otherwise, the definition just offered would apply as well to field agriculture. But we are all too well aware of the dependence of agricultural production on the vagaries of climate and weather. In contrast, bioprocesses are carried out in containers or other apparatuses that permit reasonable-but rarely perfect- control of the environment.

Like extractive biotechnology, bioprocesses have always been used by man, sometimes by accident (as in the natural formation of fermented foods) and somtimes by design. The same Egyptian tomb paintings which show the extraction of malt from grains also reveal lively-and strikingly familiar-brewing activities. By the end of the nineteenth century, such technologies had been transformed from small, local enterprises into large manufacturing plants, at least in the developed countries. During the second and third decades of this century, bioprocesses contributed a major share of chemical manufacture in these countries and, increasingly, in those developing areas that were rich in the agricultural raw materials required-molasses, for example.

The petrochemical age, originating in the developed countries during the Second World War and expanding rapidly in the following decades, dealt mortal blows to important

Cont...77..

segments of biotechnology. The production of solvent (as contrasted to beverage) ethyl alcohol by fermentation largely disappeared, as did the use of bioprocesses for the manufacture of many other industrial chemicals. In fact, the entire structure of bioprocess technology shifted from high volume, low-value ("commodity chemical") products to low-volume, high-value materials for health care and related applications. So long as the cost of petroleum-based (or natural gas-based) raw materials remained low, the prospects for a resurgence in bioprocess technology for low-cost products were poor.

Bioprocesses have been or are being used for:

-Production of cell matter (often called biomass) for consumption as food or feed (baker's yeast, mush rooms, algae, and various forms of single cell protein) or for extraction of particular substances (enzymes, nucleic acids, etc.).

-Manufacture of chemical products arising from the metabolic activities of particular cells. These products vary from those with simple molecular structures, like ethanol (ethyl alcohol), to more complex ones-aminoacids, antibiotics, and hormones, for example.

-Catalysis of highly specific chemical reactions: for example, the conversion of glucose (corn sugar) to the much sweeter fructose isomer.

Simultaneous catalysis-usually employing a mixed population of microorganisms-of a wide variety of physical and chemical changes on complex, and frequently variable, feeds. This is, of course, what ocurs in the various biological waste treatment procedures.

-Collection and concentration of minerals (and other inorganic substances) from dilute solution.

Bioprocesses offer a number of potential advantages relative to "conventional" chemical processes that are truly striking. For example.

-Multiple catalytic activities leading to the formation of complex molecular structures can be carried out in a single process step.

-The biocatalysts (cells, enzymes, etc.) are normally highly specific; a single isomer, rather than multiple forms of the desired product may be obtainable.

Cont...78..

Reaction conditions (temperature, pressure, pH) are normally mild, with the result that equipment requirements may be much less demanding.

Finally, there is the ever present prospect for renewable-resource utilization, especially important where plant raw materials are abundant and petroleum of natural gas is not. Brazil's national effort to manufacture ethanol for motor fuels from locally produced sugar and starch exemplifies this potential.

However, with the prospective advantages of bioprocesses come attendant drawbacks. These include:

-A general limitation to dilute aqueous environments resulting in low reactant concentrations, hence low reaction rates and low product concentrations. These factors lead in turn to low volumetric productives; very large equipment capacities are required, resulting in high capital investments per unit product delivered.

-Large volumes of high-quality water are needed and equally large volumes of dilute but "potent"(high biological oxygen demand) wastes are generated.

-Complex product mixtures frequently required elaborate and costly separation and purification procedures are often found.

-Finally, and of vital concern, bioprocesses are susceptible to contamination by undesirable organisms. These can disrupt manufacturing procedures or even destroy the products or render them useless.

I have treated bioprocess technology at greater length because it is clearly the focus of the current enthusiasm for biotechnology. But the incentives for fuller exploitation of the technological potential of living systems are not necessarily the same throughout the world.

The developed countries see several roles for biotechnology in their economies, but the most attractive of these is certainly the promise offered for the development of new, "high-technology" industries. In consequence, therefore, research efforts in the developed world are strongly oriented toward the preparation of biologically active substances through the agency of recombinant and other genetically manipulated organisms. Human insulin production using a recombinant bacterium is a prime-and, so far, the only major example. The developing nations can view biotechnology

Cont...79..

quite dirrerently, for it may well be more broadly suited to their needs than it is to those of the industrialized world. The frequently painful consequences arising from wholesale replication of large, centralized manufacturing operations in the developing world are all too evident. Biotechnology, on the other hand, offers prospects that appear to be much more compatible with their social and economic needs and structures.

Decentralized production is not only possible but may even be necessary if agricultural feedstocks are employed. A significant consideration here is the lesser importance of "economy of scale" so vital in the economics of petrochemical and similar plants. The inherent characteristics of bioprocess technology, summarized earlier, permit the construction of several smaller plants for a capital investment per unit output which is not marked higher than that for a single, large facility. Furthermore, the relatively simple equipment needs for many bioprocesses allow for more local fabrication and easier maintenance. These factors can lead to "low technology" options based on the exploitation of available biomass resources in a decentrailized manner and to the husbanding of scarce hard-currency assets.

An excellent survey of bioprocess technology with special emphasis on prospects for developing countries can be found in the 1979 National Research Council Publication. Microbial Processes: Promising Technologies for developing Countries, National Academy of Sciences, Washington, D.C. Washington D.C.

Despite the promise of bioprocess technology and its special attractions for developing countries, it would be foolish to interpret biotechnology so narrowly, Indeed more comprehensive and extensive exploitation of extractive biotechnology may offer the greatest benefits. Many factors support this concept. For one, the increasing recognition that many synthetic dyes constitute potential health hazards, especially in food and beverage applications, has encouraged the search for natural plant pigments. In a different context, the prospects for more extensive use of hydrocarbons from plants is gaining wider support.

These are but two examples of the potential for biotechnology that do not involve bioprocesses. They offer special attractions for societies with strong agricultural traditions and a socioeconomic fabric that might be better served through the introduction of higher value agricultural products than by massive, Western-style industrialization.

Cont...80..

If the prospective benefits of this other face of biotechnology are to be realized, a primary requirement will be a complete and accurate survey of the biological resource base in each country or region. This is an especially pressing matter now, given the concern being expressed over the possible loss of as yet unidentified plant species to land clearing. Even for those species that have been catalogued in the botanical sense, little is known about their economic potential and even less about the prospects for improving them.

In sum, biotechnology, in the broad sense, has always been a significant contributor to the fulfillment of mankind's material needs. Its special lures have been greatly enhanced by recent advances in the manipulation of genetic material. But the enthusiasm for the "new biotechnology" so evident in the developed world is no sure panacea for the less developed. We walk "in harm's way" if we allow our examination and evaluation of the prospects for biotechnology for development to follow exclusively the patterns now in vogue in Europe Japan, and the United States. Biotechnology offers an exceptional range of opportunities. The task is to identify those best suited to the needs, abilities and special circumstances of each specific region and to its unique social and economic climate.

(Bosted, 4, 3 (Oct. 1984) pp 1,4-7)

****

I N S A P U B L I C A T I O N S

Golden Jubilee Publications

Antarctica (The Unknown Continent of Unexplored Wealth) S.Z. Qasim and L.U. Joshi, Rs.7.50

Nutrition and Brain-P.N. Tandon and G. Gopinath,Rs.20.00

Solid State Chemistry- C.N.R. Rao, Rs.8.00

Liquid Crystals-S. Chandrasekhar, Rs.4.00

Perspectives in Organometallic Chemistry-R.C. Mehrotra and G. Srivastava, Rs.6.00

The Monsoons-A Perspective-P.K. Das, Rs.7.50

Rice in 2000 AD-M.S. Swaminathan, Rs.5.00

Environmental Chemical Mutagenesis-Archana Sharma, Rs.25.00

Basic building Blocks Began (..) Big Bang-An Overview of the Physics of Elementary Particles-A.N. Mitra, Rs.6.00

The Dharwar Cratan-C.S. Pichamuthu and R. Srinivasan, Rs.7.00

Perspectives in Organic Synthesis-G. Mehta and M. Nagarajan, Rs.7.00

Mathematical Model of Environment-J.N. Kapoor, Rs.5.00

Fellows of the Indian National Science Academy(Past and Present) Biographical Notes, Rs.110.00

Addresses by Presidents (1935-1984) of INSA, Rs.350.00

INSA Medal Lectures (set of 2 volumes), Rs.500.00

Science in India-Changing Profile Edited by S.K. Mukherjee, FNA and B.V. Subbarayappa, Rs.20.00

Status Report on Fifty Years of Radio Science Iin India-A.P. Mitra, Rs.8.00

Perspective Report on Genetics and Molecular Biology of Rhizobia-N.K. Notani, et al. Rs.8.00

Indian Agriculture in 2000 AD-H.K. Jain, Rs.10.00